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ACOUSTIC TESTS ON A NEW MOTOR GENERATOR SYSTEM FOR THE MINUTEMAN LAUNCH CONTROL CENTERS AT ALPHA 01 AND SIERRA 00, MALMSTROM AFB MT

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BROOKS AIR FORCE BASE, TEXAS 78235-5000

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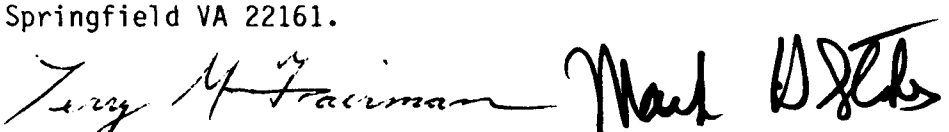

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Field tests of the acoustic performance of a new motor generator system (MGS) were performed at Minuteman Launch Control Centers (LCC) Alpha 01 and Sierra 00, Malmstrom AFB MT. This same MGS unit was accepted for use after the Hill Engineering Test Facilities (HETF) acoustic performance studies conducted in 1988. Rivet Mile from the Ogden ALC began installation of the new MGS at Malmstrom in the spring of 1990. Performance tests were requested by OO-ALC/MMGRMM, and SAC, to compare with the HETF data and document the LCC acoustic environment with the new MGS operating in a field setting. This report presents our findings.

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Acoustic Tests on a New Motor Generator System for the Minuteman Launch Control Centers at Alpha 01 and Sierra 00, Malmstrom AFB MT

INTRODUCTION

Purpose

This report presents the findings and recommendations of an acoustic field performance evaluation survey on a new motor generator system (MGS) for the Strategic Air Command (SAC) Minuteman Launch Control Centers (LCC). The survey was performed at the request of OO-ALC/LMMICB, the Directorate of Materiel Management for the Minuteman LCCs, at Hill AFB UT, during the period 22 Apr to 5 May 90. Tests were performed at two LCCs at Malmstrom AFB MT, since this was the first operational wing receiving the new MGS. Rivet Mile from Ogden ALC performed the installation. Follow-up acoustic noise data was desired by OO-ALC and SAC to compare to the measurements obtained on previous surveys at the Hill Engineering Test Facilities (HETF) during qualification testing of the new MGS. SAC also desired the measurements to demonstrate the noise reduction of the new MGS versus the old system and to document the acoustic environment of the capsule crews.

Background

Recommendations from USAFOEHL Report 85-075EH146DNA, "Noise and Vibration in Minuteman Launch Control Centers," were used by TRW, a USAF consultant for the Minuteman system, to design a noise specification for a new, quieter motor generator system. The Boeing Company, as primary contractor, subcontracted to American Electronics, Inc., the design and construction of a new MGS which would, among other criteria, meet the PNC-50 (preferred noise criterion) acoustic performance specification for noise in the LCC. The AFOEHL performed the post critical design review acoustic tests at the HETFs, 29 Nov to 1 Dec 88, and reported results in AFOEHL Report 89-033, "Acoustic Tests on a New Motor Generator System for the Minuteman Launch Control Centers in Hill Engineering Test Facilities I and II, Hill AFB UT." These test results indicated the new MGS was not meeting the desired LCC acoustic criteria. Modifications were made on the MGS and final qualification tests were performed in the HETFs on a production line version of the MGS, 17-21 Jul 89. These tests also indicated the new MGS was not meeting the PNC-50 criteria for noise when hard mounted to the MGS subfloor particularly on AC operation. There was still significant structure-borne acoustic energy from MGS vibrations. It was determined this problem could be minimized with the use of vibration isolation pads of 1/2 inch thick rubber placed between the MGS

Note: This report was accomplished by the Air Force Occupational and Environmental Health Laboratory (AFOEHL), which is now the Armstrong Laboratory, Occupational and Environmental Health Directorate.

frame and metal subfloor at each mounting bolt. With this mounting scheme, the acoustic energy in the LCC from the MGS was significantly reduced to the point of meeting the PNC-50 criteria. The new MGS was accepted with the vibration isolation mounting scheme. Now Rivet Mile from Ogden is beginning to install the new MGS at operational sites in SAC, beginning at Malmstrom AFB.

Scope

Acoustic measurements would be obtained at both the commander's chair and the deputy commander's chair in the same fashion the measurements were obtained in the previous two studies in the HETFs. Test sites were LCCs Alpha 01 and Sierra 00. This report will compare the measurements obtained at Malmstrom with those obtained during the qualification tests in the HETFs. The data will also be compared to the latest noise criterion curves.

DISCUSSION

Method

All data collection and analyses were performed using the Norwegian Electronics Model 830 dual channel real time analyzer. The channel 1 microphone monitored the acoustic energy at the commander's chair and the channel 2 microphone monitored the acoustic energy at the deputy commander's chair. Both microphones were set on tripods at 1.15 meters above the floor, which is the average, sitting, ear level height. Each microphone was positioned parallel to the floor and pointed toward the ear of the crew person. Measurements were made without the crew person in place. Three 30-second average measurements were obtained at both the right and left ear positions, and these six measurements were averaged to obtain the average noise level at each crew position for each measurement condition.

The basic measurement conditions included the old and new motor generator units at both AC and DC power with no load and no acoustic dampening materials in place. These conditions provided a look at the improved acoustics of the new MGS versus the old MGS in a field setting, and data comparable to the HETF data. Additional measurements with the new MGS included operating the emergency air conditioning unit (EACU), and placing acoustic dampening materials in the LCC (i.e., carpet and baffles).

Results

Acoustic measurement results are presented in Appendixes A - G. Appendix A and B present acoustic performance measurement data at the crew positions compared to a reference criteria (i.e., measured level minus the criteria). Therefore, the graphic displays indicate how many decibels the measured levels were above or below the criteria. The criteria line is the zero level on the y-axis. The accompanying table shows numerically the actual decibel level above or below the criteria.

Appendix A presents the PNC-50 criteria collected at Alpha 01 and Sierra 00. These data include measurements of both the old and the new MGS under various operating and load conditions, as well as various capsule configurations (i.e., carpet and acoustic baffles). For site Alpha 01, the old MGS was clearly out of specification at the 1000 and 2000 Hertz (Hz) octave band frequencies under both AC and DC power operation. The worst case was in the 1000 Hz octave band at the deputy commander's chair (DCC) with the MGS in AC power operation and no load (NL). Here the measured noise level exceeded the PNC-50 criteria for that octave band by 15.2 decibels (dB). The 1 and 2 kHz octave bands are critical speech frequencies where excess noise can cause a great deal of voice communication interference. With the new MGS at Alpha 01 under the same operating conditions, a dramatic noise reduction has been achieved, although the PNC-50 criteria are still exceeded by 5.5 dB in the 2 kHz octave band at the commander's chair (CC) under AC operation (3 dB at the DCC). Under DC operation, the 31.5 Hz octave band was exceeded by 5.2 dB at the CC and the 500 Hz octave band was exceeded by 1.7 dB at the DCC.

Similar results were obtained at site Sierra 00. Here the most offending frequency from the old MGS was the 250 Hz octave band which exceeded the PNC-50 criteria by 12 to 13 dB in all cases. At Sierra 00 we had the opportunity to collect acoustic measurements with the new MGS in both the serviced (SVC) and unserviced conditions. The new MGS in the unserviced condition with the vibration isolation mounting technique reduced the measured levels in the 250 Hz octave band well below the criteria. Levels exceeding the PNC-50 criteria by about 5 dB were observed in both the 31.5 Hz and 500 Hz octave bands. A comparison of measurements obtained at Sierra 00 with and without the carpet in place and the MGS in the unserviced condition indicates the carpet is effective in reducing the 500 Hz octave band to a level below the criteria in all cases except at the DCC with the MGS in DC operation. Here a 3 dB reduction was achieved, but the level still exceeds the criteria by 3 dB. The 500 Hz octave band is also a critical speech frequency and therefore reductions of 3 dB (equivalent to a halfing of acoustic energy) in this octave band are significant. After the new MGS had been serviced, measurements indicated the carpet was not as effective in reducing the level in the 500 Hz octave band. In fact, the 500 Hz octave band SPL actually goes up by as much as 3 dB at the CC with the MGS in DC operation. It is reduced 1 dB at the DCC under the same conditions. This anomaly is difficult to explain. Having the carpet in place should provide a small reduction in measured noise levels in all cases. It is possible something other than the MGS alone was operating at the time of the measurements, and we simply were not aware of it.

Appendix B presents all the same data and measurement locations and conditions as Appendix A except now comparing to the new NCB-50 curve (Balanced Noise Criterion Curves). The NCB curves are an updated set of NC (Noise Criterion) curves developed and published in 1988. These curves are criteria which apply to occupied interior spaces with all systems running. The NCB curves allow slightly higher levels at almost all octave band frequencies and provide criteria at the lower 16 Hz octave band frequency. As a result, when the same data is compared to the NCB-50 curve, the results look even better than with the PNC-50 curve. Although the new MGS was not designed to comply with the NCB curves, results showing the NCB comparison are provided since any new work in the LCCs would have to incorporate the new criteria for the acoustic environment.

Appendixes C - G present comparison charts and tables showing actual measured sound pressure levels (SPL). Each figure compares two data sets with the reference PNC-50 criterion. Appendix C compares the old versus the new MGS. Appendix D compares the commander's chair position with the deputy commander's. Appendix E shows the Sierra 00 LCC acoustic environment with and without carpet. Appendix F presents the Sierra 00 LCC acoustic environment with the serviced and unserviced MGS. Appendix G compares the Alpha 01 LCC acoustic environment with the measured noise levels in the Hill AFB HETF I. A comparison of the larger Sierra 00 facility with the Hill AFB HETF II cannot be done since the proper HETF II data was never collected. All SPL data for Sierra 00 shown in these comparison charts uses the serviced MGS data since it shows the best achievable levels. The overall levels in Appendix G comparing Alpha 01 to HETF I indicate the HETF data is from 1.5 dB to 7.4 dB lower than the field data.

Observations

The table is a summary of preferred speech interference levels in the LCC at Alpha 01 and Sierra 00. PSIL values of 49 dB for the large LCCs and 51 dB for the small LCCs had been recommended in USAFOEHL Report 85-075EH146DNA as necessary to achieve a "normal voice" communication level between speaker and listener at the console separation distances. These PSIL values are met with this new MGS for all conditions except when the emergency air conditioning unit (EACU) is operating. Of course it is the EACU itself, not the MGS, which causes the recommended PSIL to be exceeded.

Summary of Preferred Speech Interference Levels (PSIL) in Alpha 01 and Sierra 00 LCCs at the Commander's and Deputy Commander's chairs.

	MEASUREMENT LOCATION	MGS MODE	ECS MODE	EACU MODE	CARPET/ BAFFLES	PSIL (dB)
SIERRA 00	CC	AC	OFF	OFF	YES	39.1
	DCC	AC	OFF	OFF	YES	40.1
	CC	DC	OFF	OFF	YES	38
	DCC	DC	OFF	OFF	YES	37.7
ALPHA 01	CC	AC	OFF	OFF	NO	46.4
	DCC	AC	OFF	OFF	NO	46.3
	CC	DC	OFF	OFF	NO	44.3
	DCC	DC	OFF	OFF	NO	45.5
	CC	AC	ON	OFF	YES	50.1
	DCC	AC	ON	OFF	YES	51.9
	CC	DC	ON	OFF	YES	49.2
	DCC	DC	ON	OFF	YES	51.1
	CC	AC	OFF	OFF	YES	38
	DCC	AC	OFF	OFF	YES	41.6
	CC	DC	OFF	OFF	YES	36.9
	DCC	DC	OFF	OFF	YES	40.1
	CC	AC	ON	ON	YES	64.9
	DCC	AC	ON	ON	YES	67.4

CONCLUSION

The new motor generator systems installed in the launch control centers at Alpha 01 and Sierra 00 at Malmstrom AFB MT did not meet the technical requirements of the PNC-50 criteria. The modified PNC-50 criteria developed by 00-ALC/LMMICB and specified in the contract states: "The acoustical noise level of the M-G (MGS) shall not exceed 3 dB above the following values (maximum noise level for PNC-50 values) over the frequency bands (octave-band center frequency) indicated provided that any noise over these levels is offset by an equal or greater amount at other octave bands." Loosely interpreted, our measurement results could be shown to meet the modified criteria, although the 3 dB limit is exceeded in several instances. Measurement results meeting or not meeting the criteria is a moot point at this time since the new motor generators have already been accepted and are being installed. The main point is the amount of noise reduction which has been achieved with the new MGS. Variations in noise level can and probably will occur from capsule to capsule. The PSIL values indicate an acceptable voice communications environment has been achieved.

RECOMMENDATIONS

The EACU remains a major noise source in the LCCs when it is operating. Although it is not in constant use, it will cause voice communication problems whenever it is on. We continue to recommend replacement of these units with newer, quieter operating models.

REFERENCES

1. AFR 161-35, Hazardous Noise Exposure (9 April 1982).

2. Fairman, T. M., "Acoustic Tests on a New Motor Generator System for the Minuteman Launch Control Centers in Hill Engineering Test Facilities I and II, Hill AFB UT." AFOEHL Report 89-033EH0086DNA, April 1989.

3. Fairman, T.M., "Noise and Vibration in Minuteman Launch Control Centers," USAF OEHL Report 85-075EH146DNA.

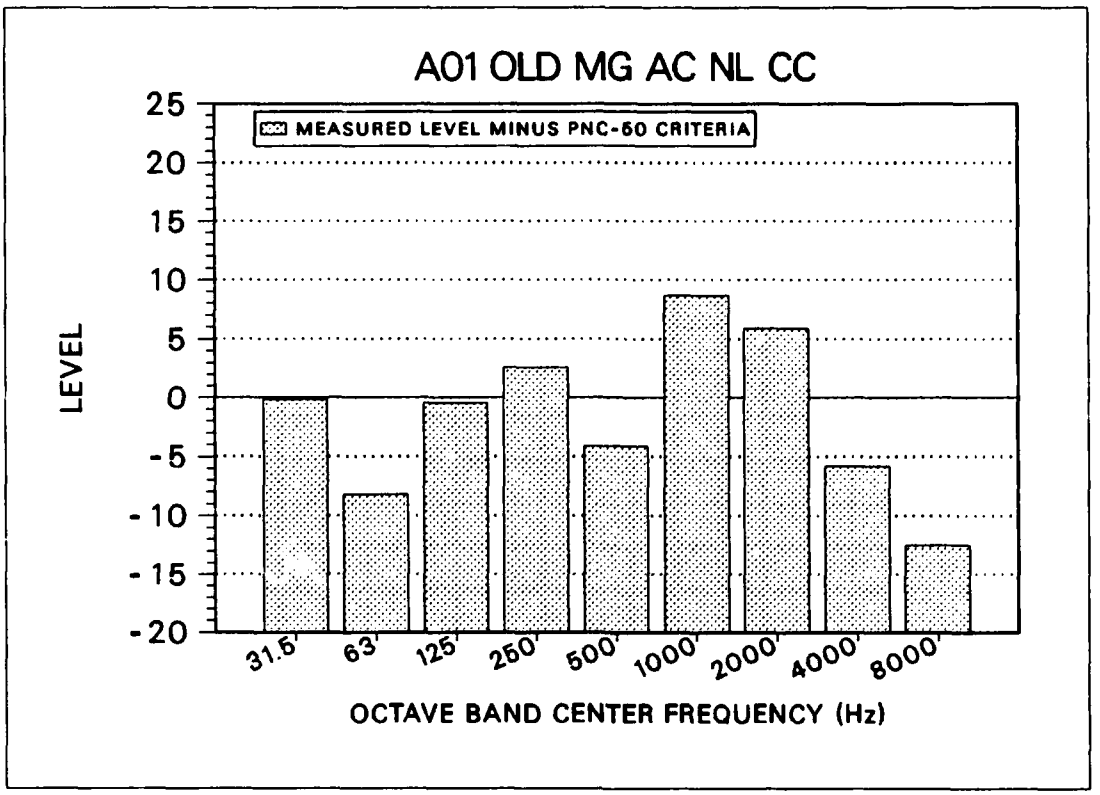
GLOSSARY OF TERMS

ABBREVIATION	MEANING
AC	AC Power Operation of Motor Generator Set
AO1	Alpha 01 Launch Control Center
BAF	Acoustic Baffles in LCC ceiling
CC or C	Commander's Chair
DC	DC Power Operation of Motor Generator Set
DCC or D	Deputy Commander's Chair
EACU	Emergency Air Conditioning Unit
ECS	Environmental Control System
HETF	Hill Engineering Test Facility
LCC	Launch Control Center
MG or MGS	Motor Generator Set
NL	No Load on Motor Generator Set
NEW	New Motor Generator Set
OLD	Old Motor Generator Set
SOO	Sierra 00 Launch Control Center
SVC	Serviced Motor Generator Set

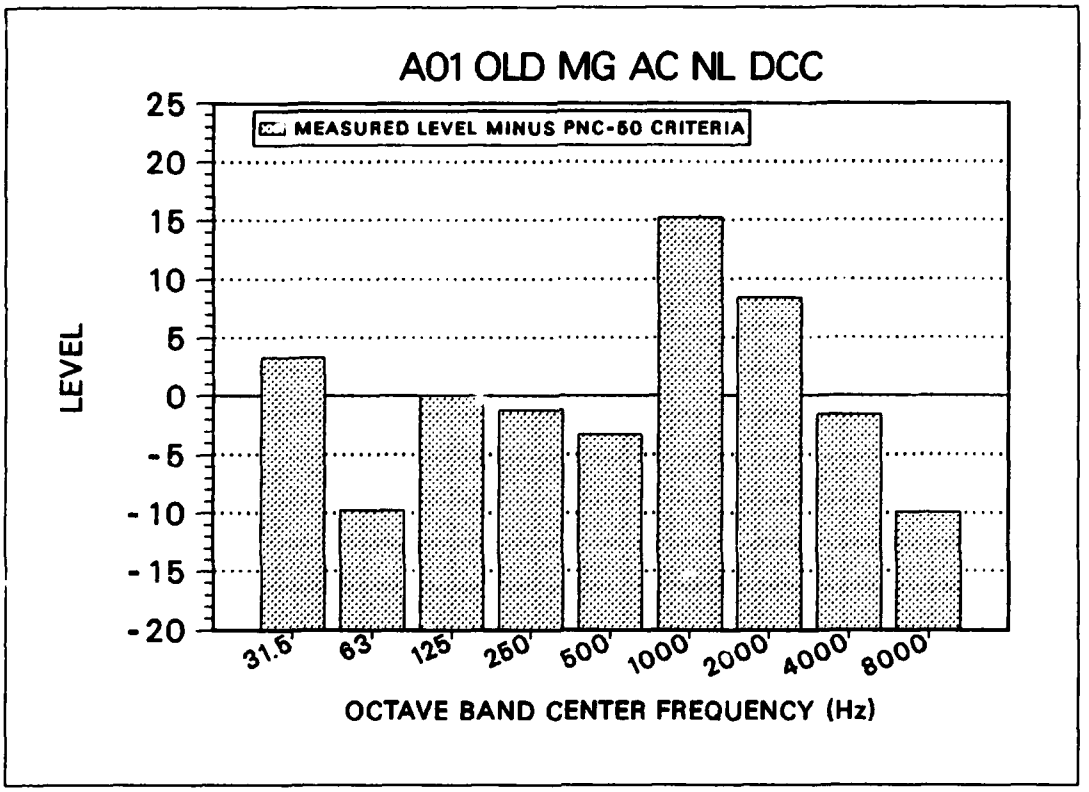
APPENDIX A

Performance Measurements at the Crew Positions

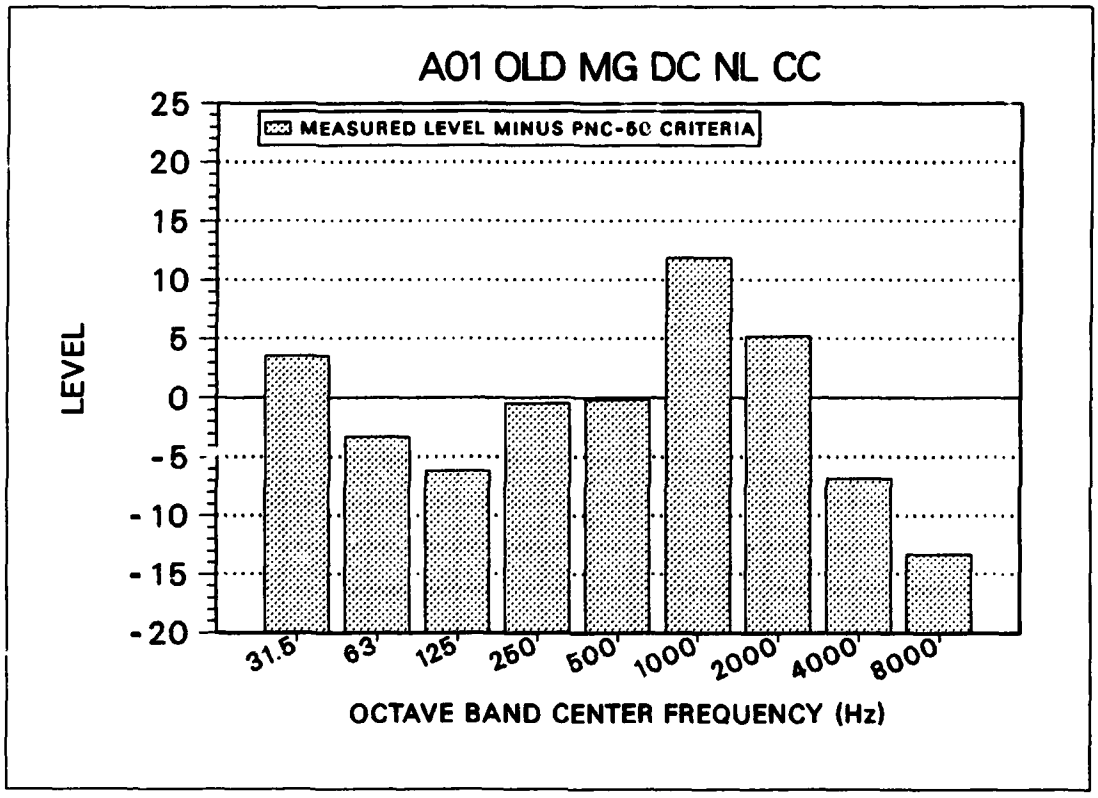
Measured Levels re. PNC-50



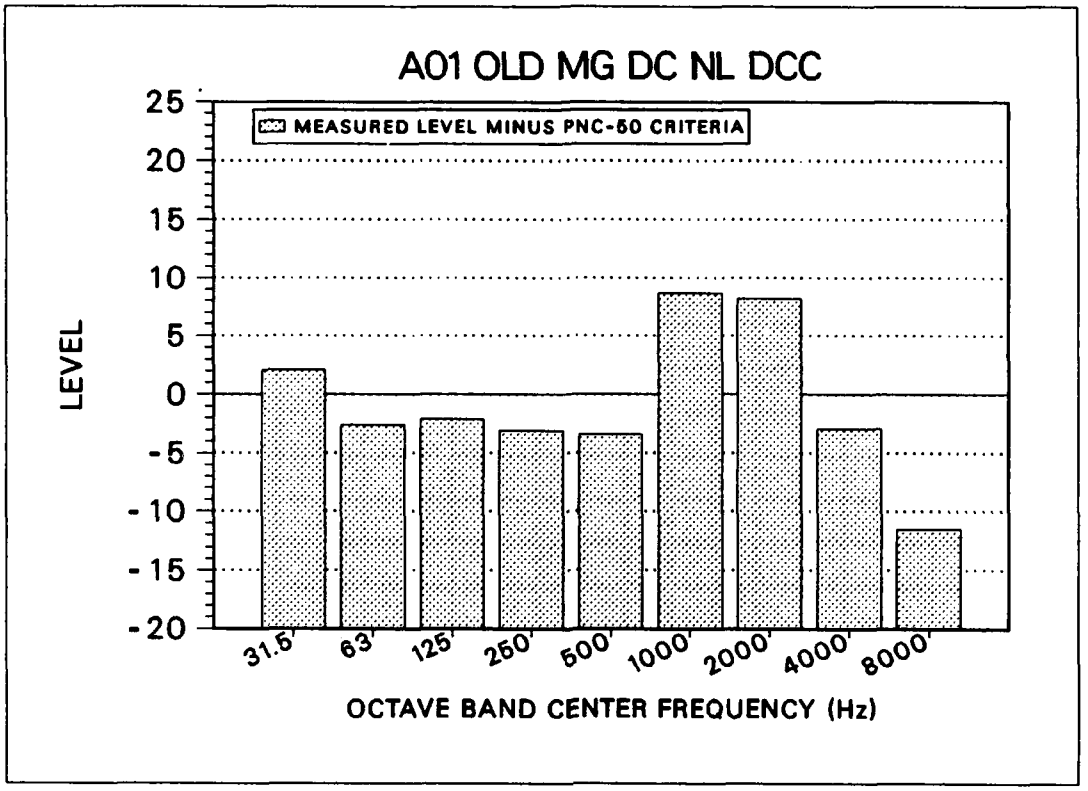
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	69.9	70	−0.1
63	57.8	66	−8.2
125	61.5	62	−0.5
250	60.6	58	2.6
500	49.9	54	−4.1
1,000	58.7	50	8.7
2,000	51.9	46	5.9
4,000	37.2	43	−5.8
8,000	30.4	43	−12.5



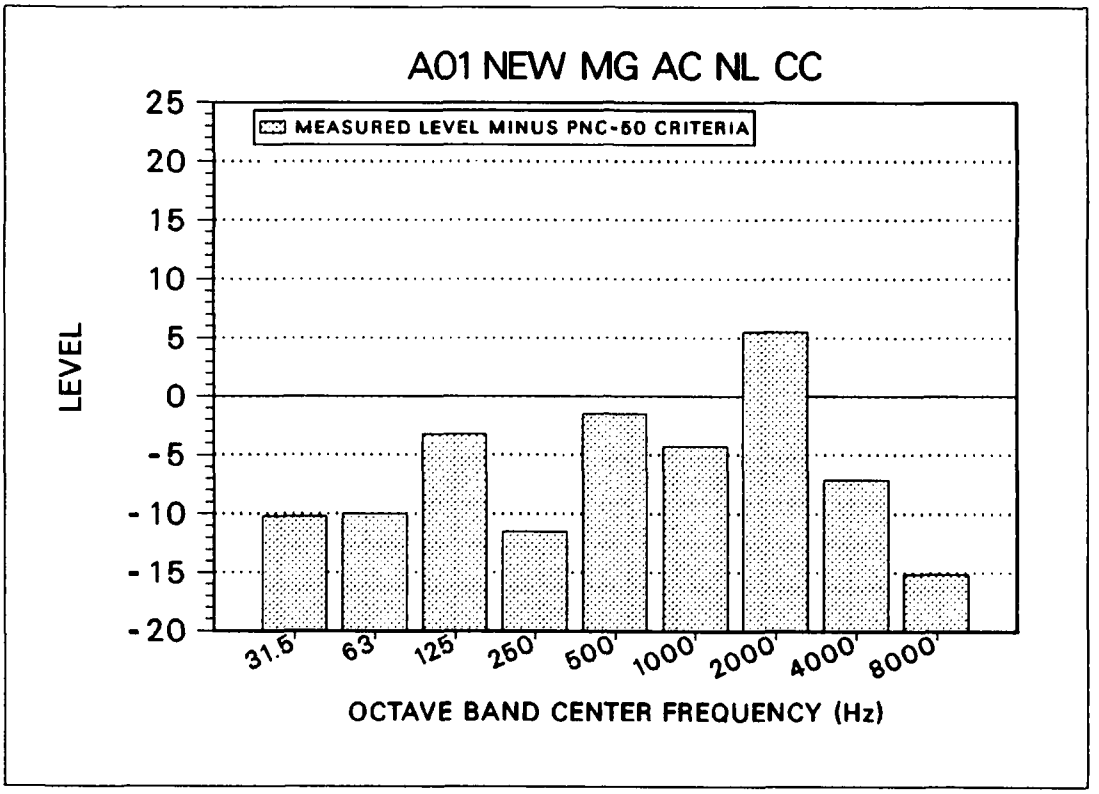
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	73.3	70	3.3
63	56.2	66	−9.8
125	62	62	0
250	56.8	58	−1.2
500	50.7	54	−3.3
1,000	65.2	50	15.2
2,000	54.4	46	8.4
4,000	41.4	43	−1.6
8,000	33.1	43	−9.9



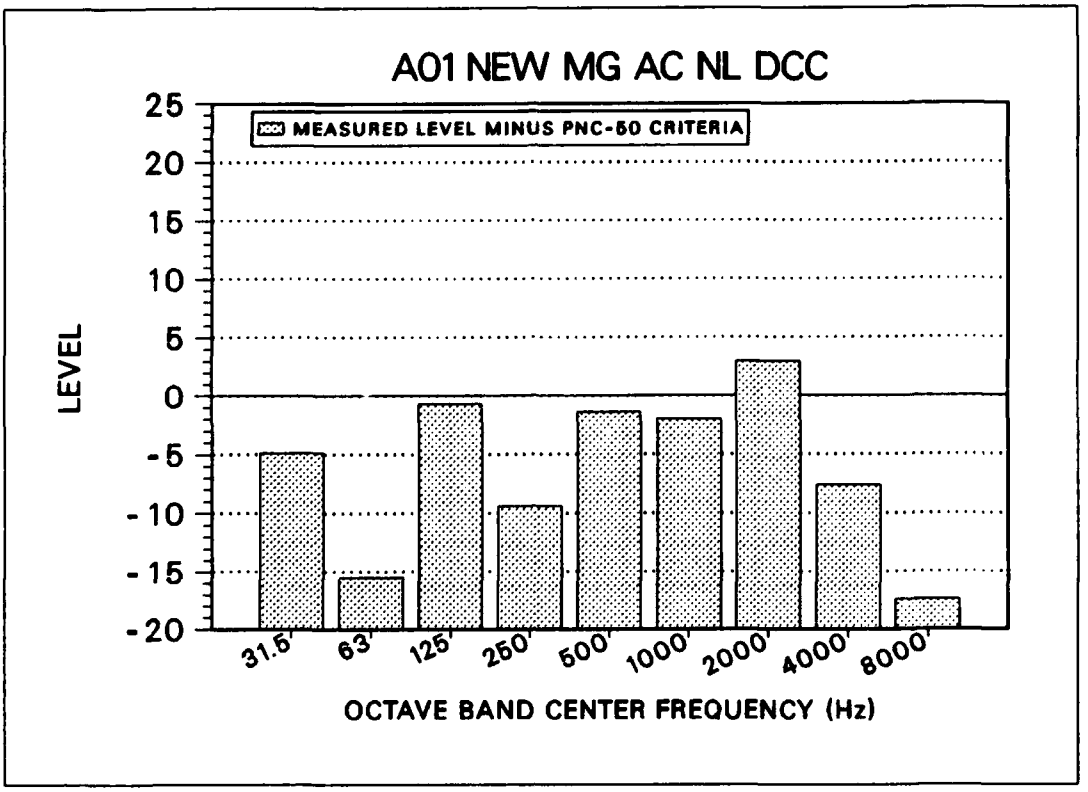
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	73.4	70	3.5
63	62.7	66	-3.3
125	55.8	62	-6.2
250	57.5	58	-0.5
500	53.8	54	-0.1
1,000	61.9	50	11.9
2,000	51.2	46	5.2
4,000	36.2	43	-6.8
8,000	29.7	43	-13.3



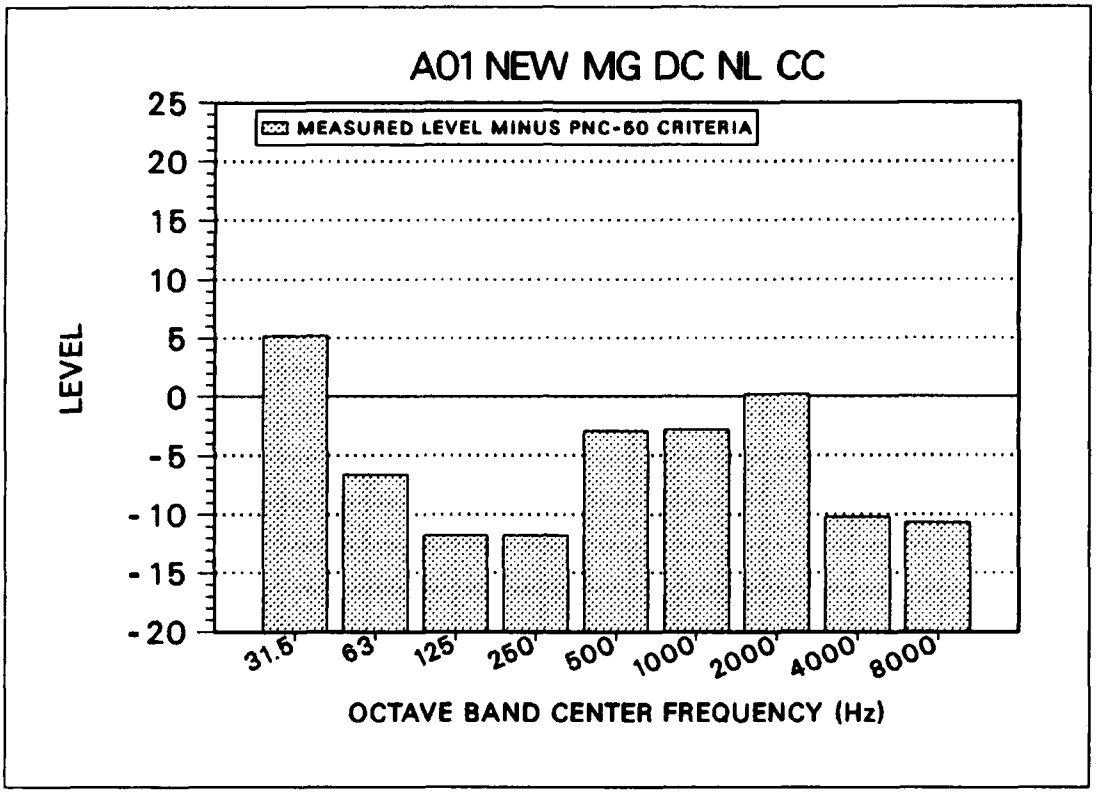
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	72.1	70	2.1
63	63.4	66	−2.6
125	59.9	62	−2.1
250	54.8	58	−3.1
500	50.6	54	−3.4
1,000	58.7	50	8.7
2,000	54.1	46	8.2
4,000	40.1	43	−2.9
8,000	31.5	43	−11.5



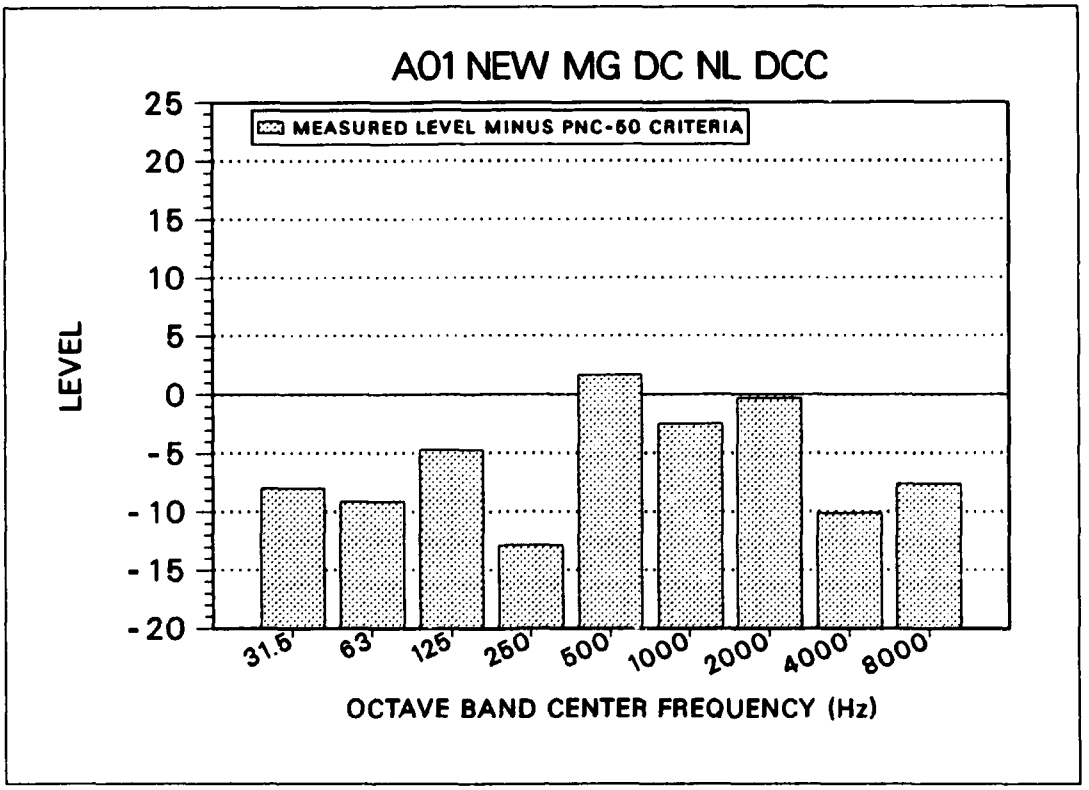
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	59.8	70	−10.2
63	56	66	−10
125	58.7	62	−3.2
250	46.5	58	−11.5
500	52.5	54	−1.5
1,000	45.6	50	−4.3
2,000	51.5	46	5.5
4,000	35.9	43	−7.1
8,000	27.9	43	−15.1



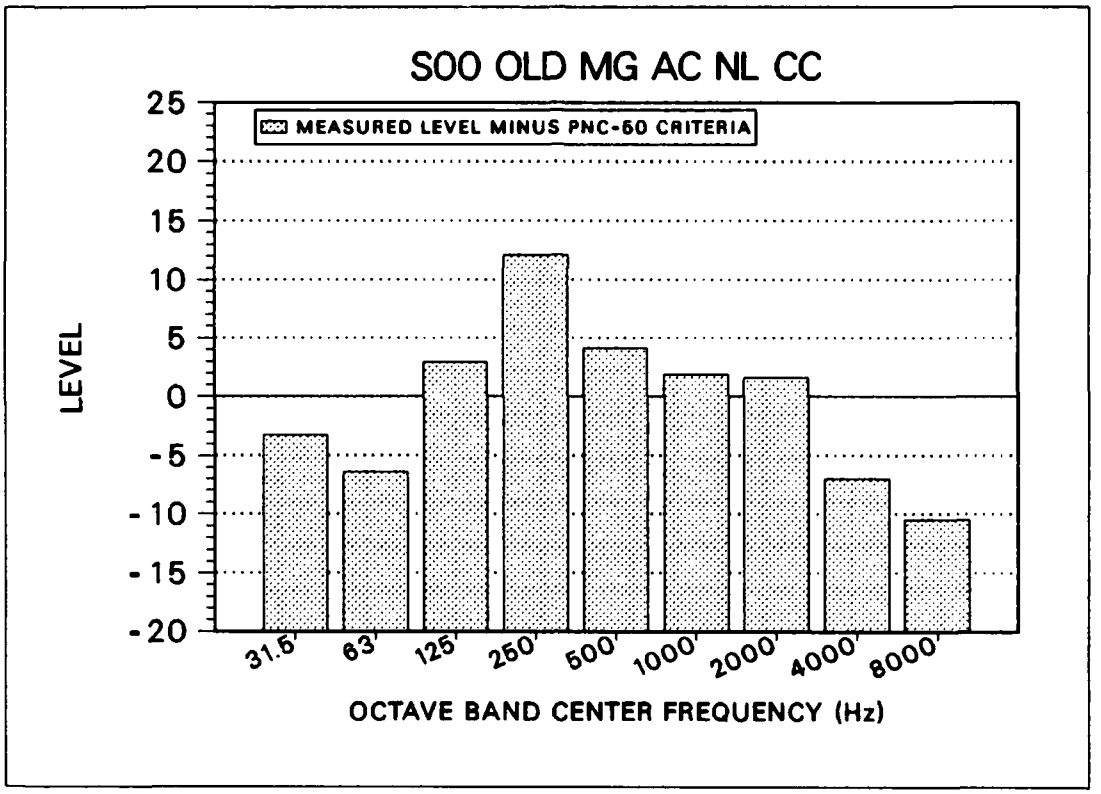
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	65.1	70	−4.9
63	50.5	66	−15.5
125	61.3	62	−0.7
250	48.6	58	−9.4
500	52.6	54	−1.4
1,000	48	50	−2
2,000	49	46	3
4,000	35.4	43	−7.6
8,000	25.6	43	−17.4



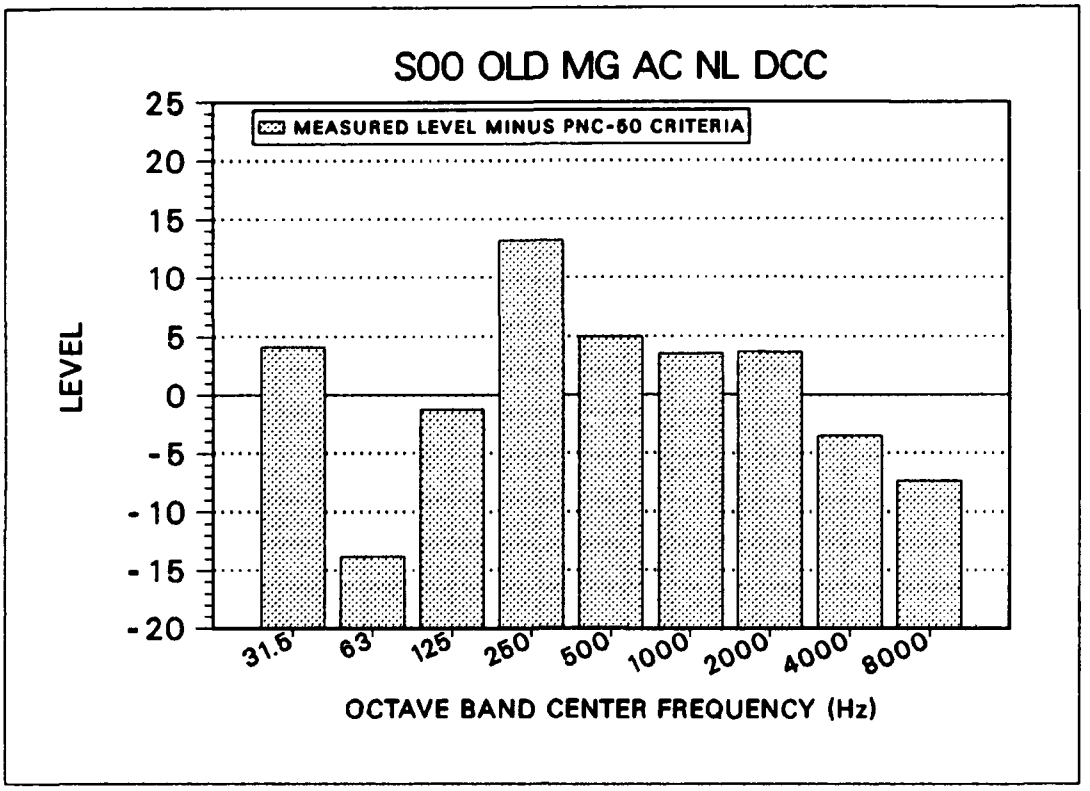
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	75.1	70	5.2
63	59.4	66	−6.6
125	50.2	62	−11.8
250	46.2	58	−11.8
500	51.1	54	−2.9
1,000	47.2	50	−2.8
2,000	46.2	46	0.2
4,000	32.7	43	−10.2
8,000	32.3	43	−10.7



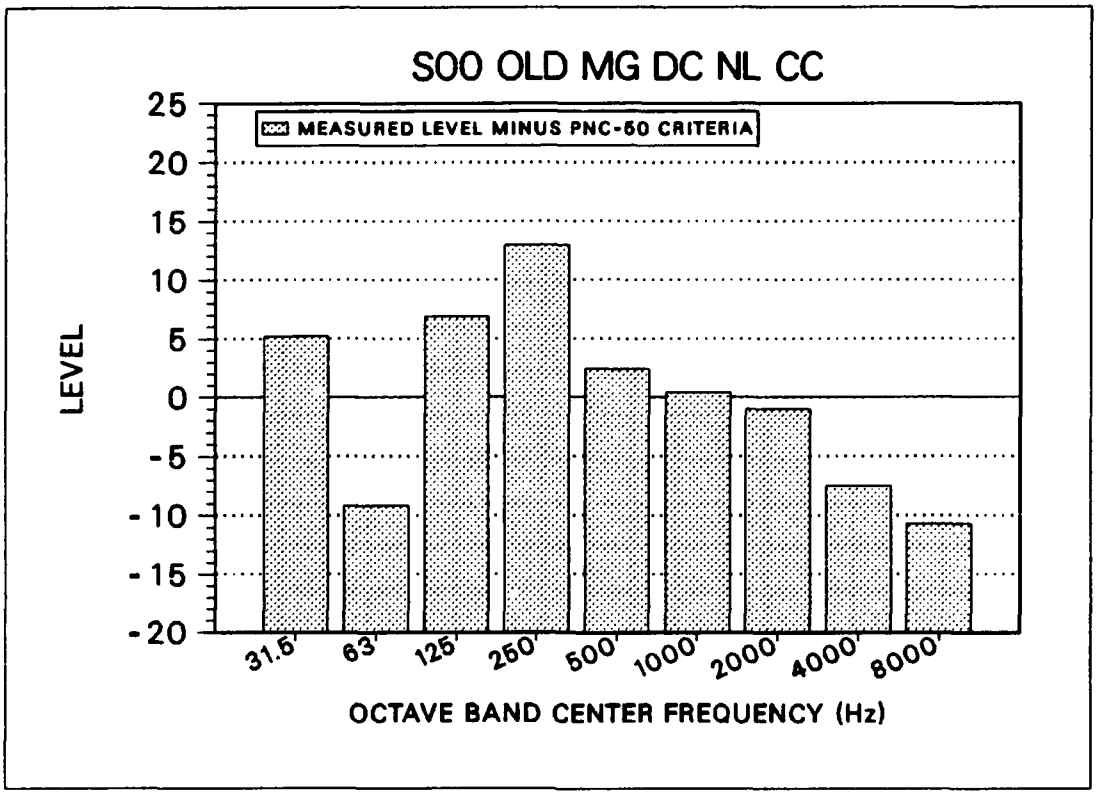
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	62	70	−8
63	56.9	66	−9.1
125	57.3	62	−4.7
250	45.1	58	−12.9
500	55.7	54	1.7
1,000	47.5	50	−2.5
2,000	45.7	46	−0.3
4,000	32.9	43	−10.1
8,000	35.4	43	−7.6



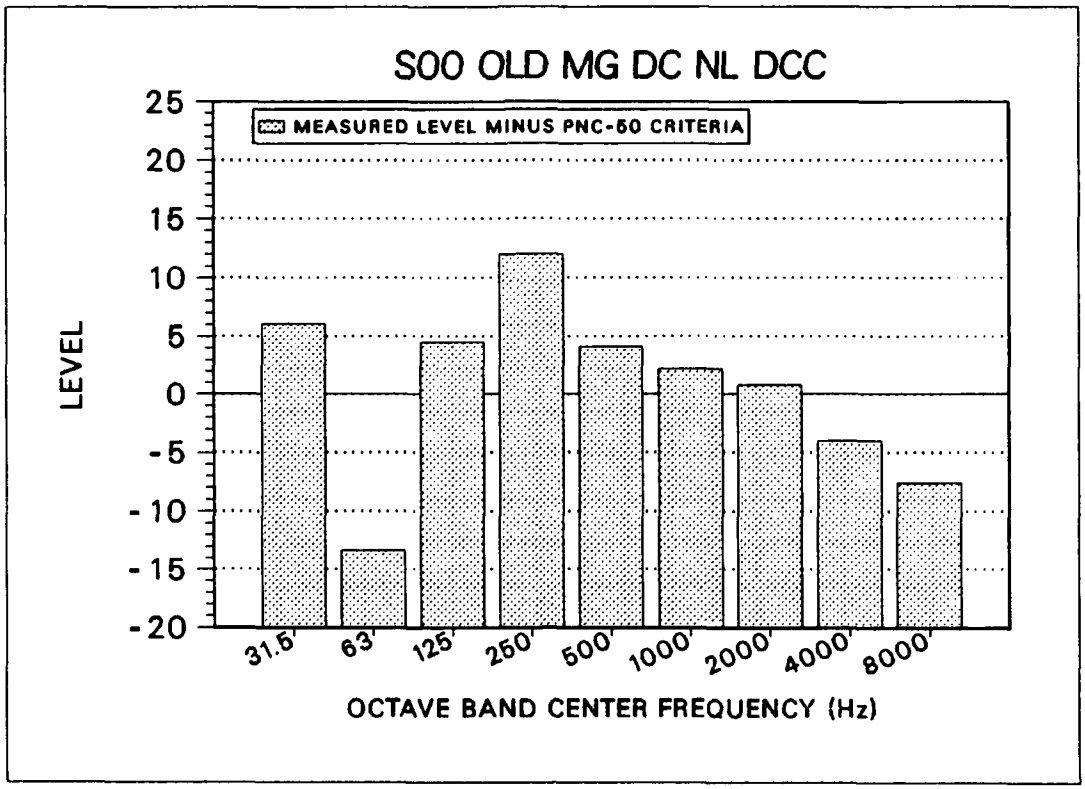
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	66.8	70	−3.2
63	59.5	66	−6.4
125	64.9	62	2.9
250	70.1	58	12.1
500	58.1	54	4.1
1,000	51.9	50	1.9
2,000	47.6	46	1.6
4,000	36	43	−7
8,000	32.5	43	−10.5



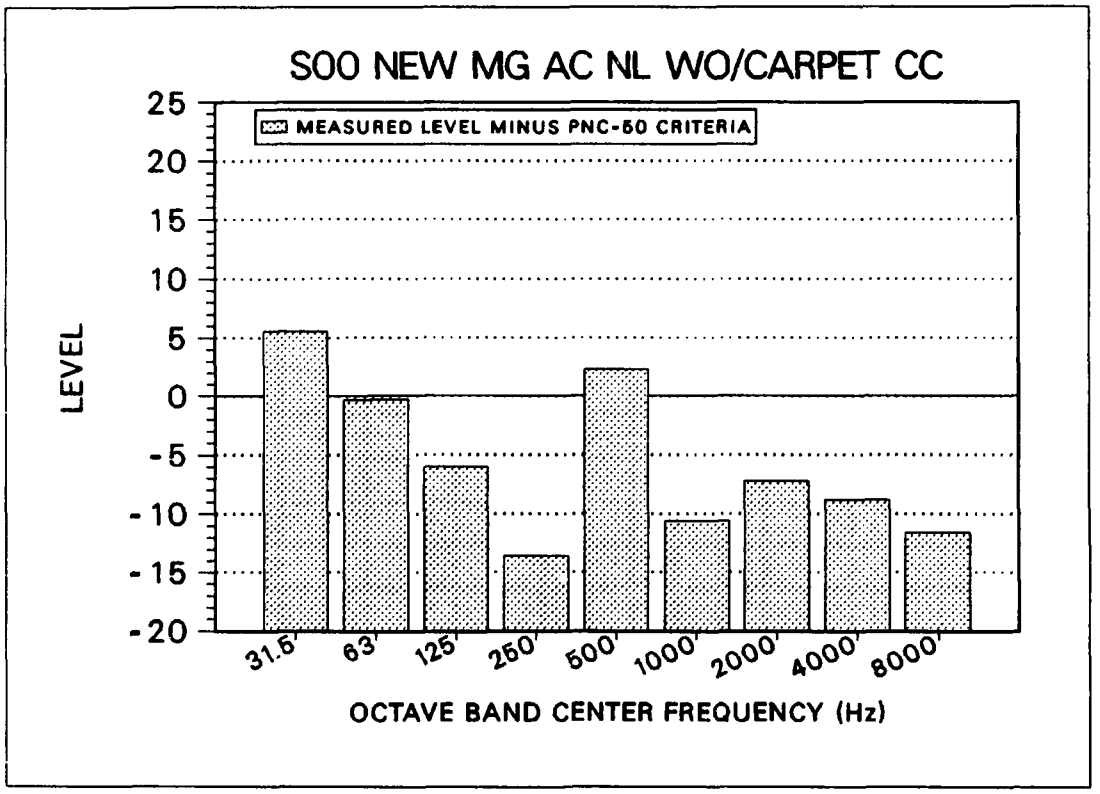
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	74.1	70	4.1
63	52.2	66	−13.8
125	60.8	62	−1.2
250	71.2	58	13.2
500	59	54	5
1,000	53.5	50	3.5
2,000	49.7	46	3.7
4,000	39.5	43	−3.5
8,000	35.6	43	−7.4



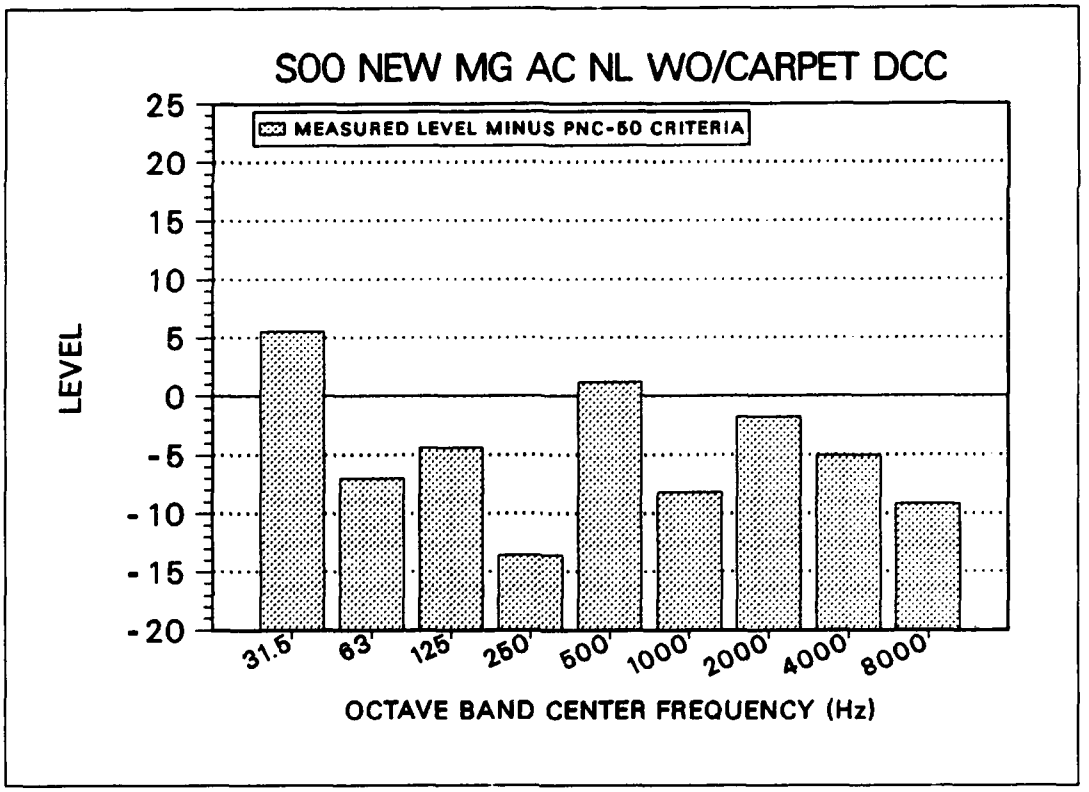
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	75.1	70	5.2
63	56.8	66	−9.2
125	68.9	62	6.9
250	71	58	13
500	56.4	54	2.4
1,000	50.4	50	0.4
2,000	45	46	−1
4,000	35.5	43	−7.5
8,000	32.3	43	−10.7



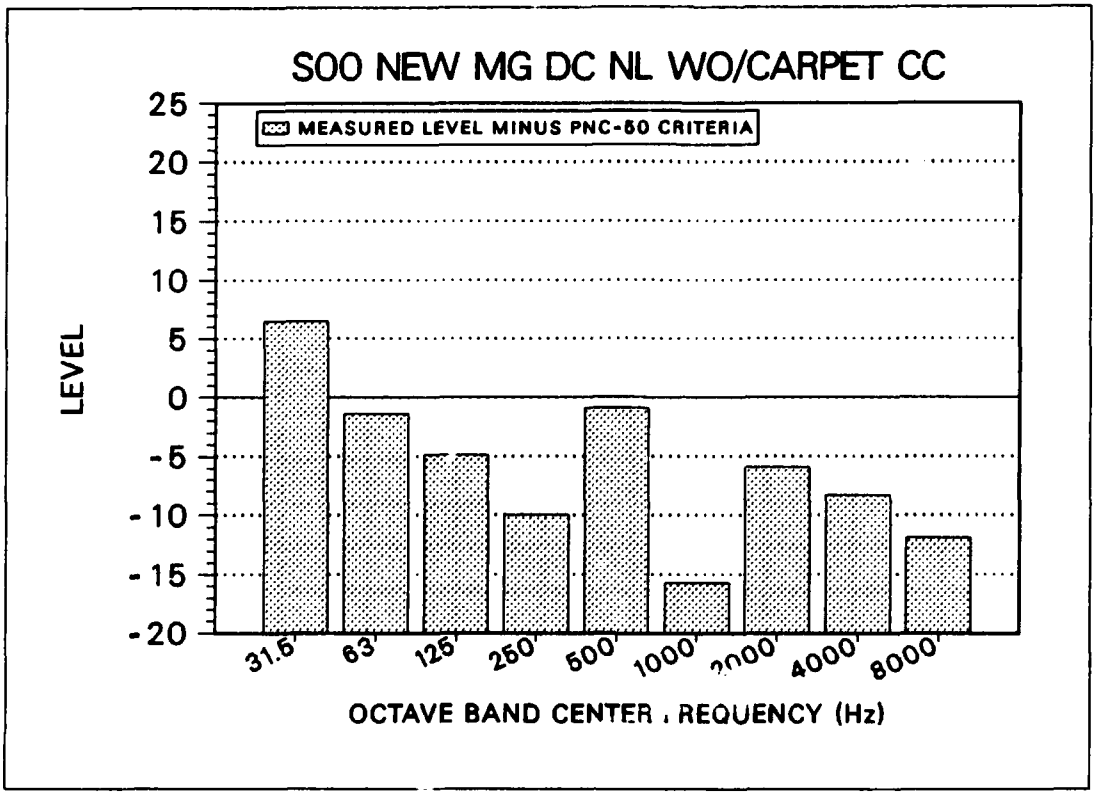
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	76.1	70	6.1
63	52.5	66	−13.4
125	66.5	62	4.5
250	70	58	12
500	58.1	54	4.1
1,000	52.2	50	2.2
2,000	46.8	46	0.8
4,000	39	43	−4
8,000	35.4	43	−7.6



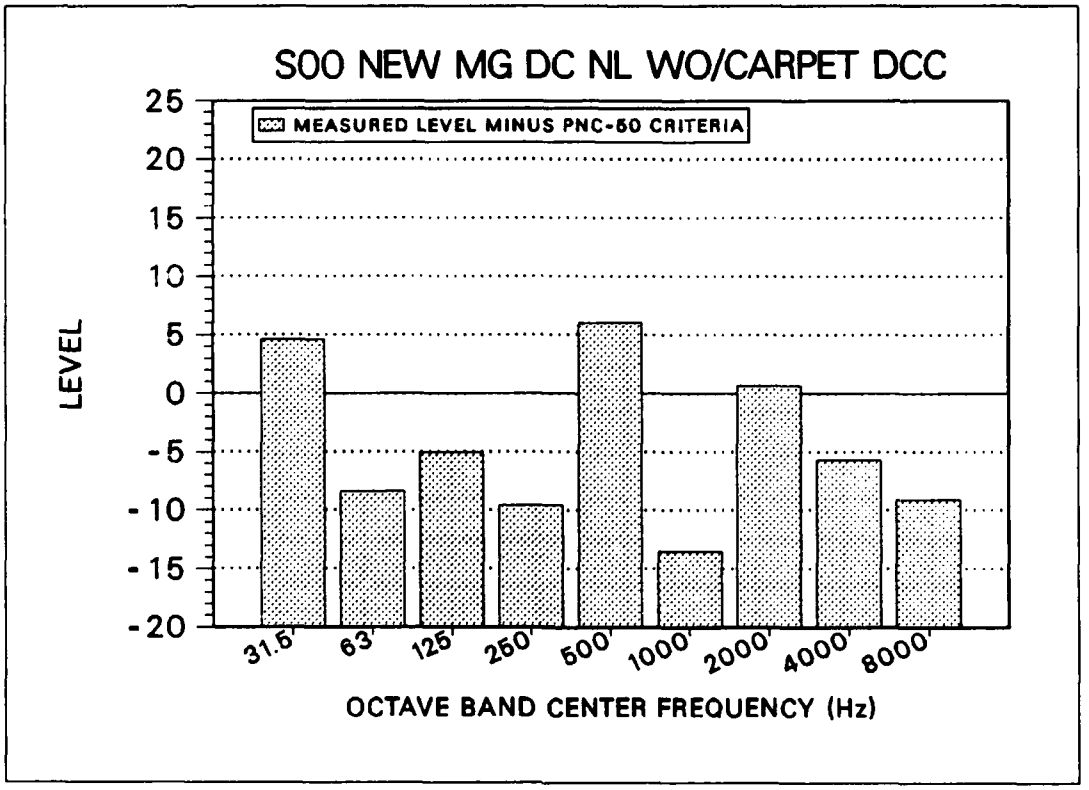
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	75.5	70	5.6
63	65.7	66	−0.3
125	56	62	−6
250	44.4	58	−13.6
500	56.3	54	2.3
1,000	39.4	50	−10.6
2,000	38.8	46	−7.2
4,000	34.1	43	−8.8
8,000	31.3	43	−11.6



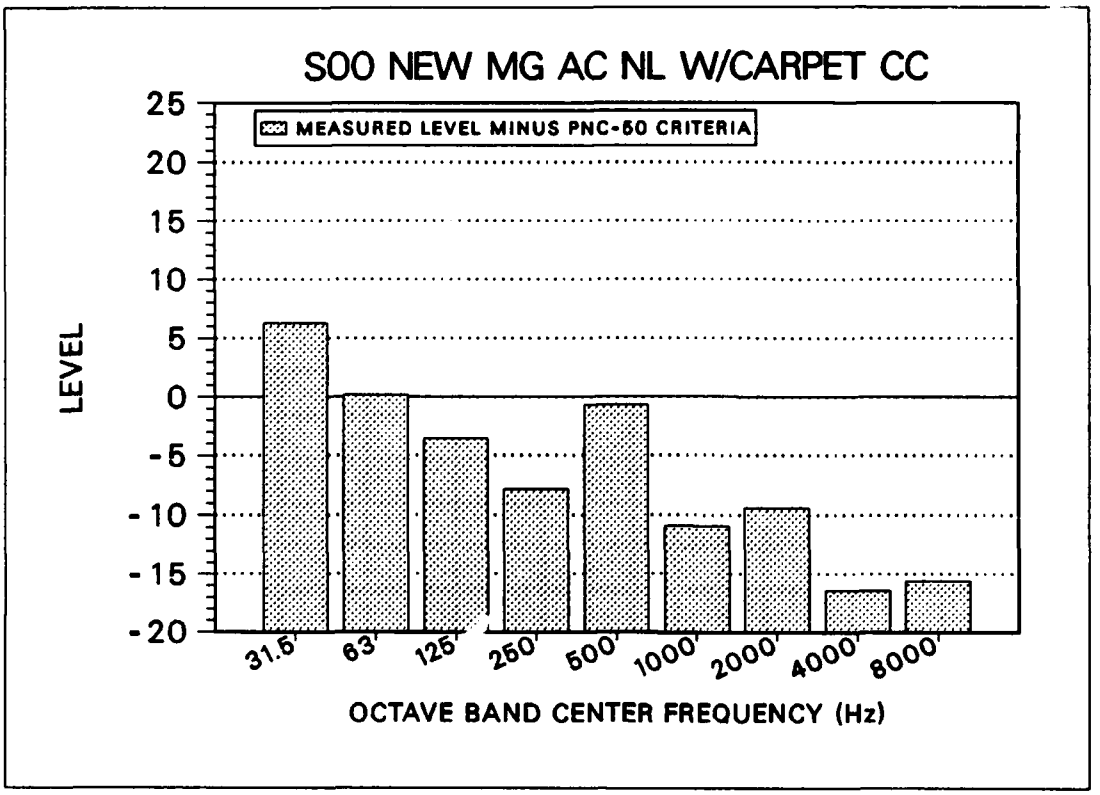
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	75.4	70	5.5
63	59	66	–7
125	57.6	62	–4.4
250	44.4	58	–13.6
500	55.2	54	1.2
1,000	41.8	50	–8.2
2,000	44.1	46	–1.8
4,000	38	43	–5
8,000	33.8	43	–9.2



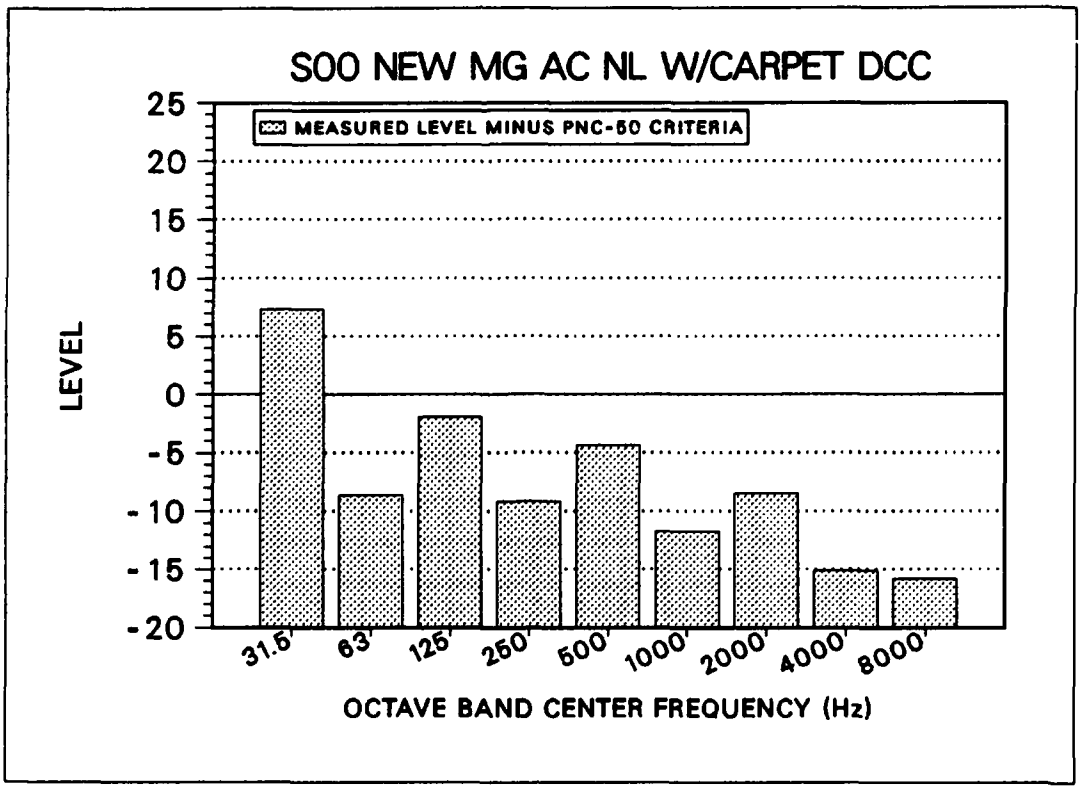
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	76.5	70	6.5
63	64.5	66	−1.4
125	57.1	62	−4.9
250	48	58	−10
500	53.1	54	−0.9
1,000	34.3	50	−15.7
2,000	40.1	46	−5.9
4,000	34.7	43	−8.3
8,000	31.1	43	−11.9



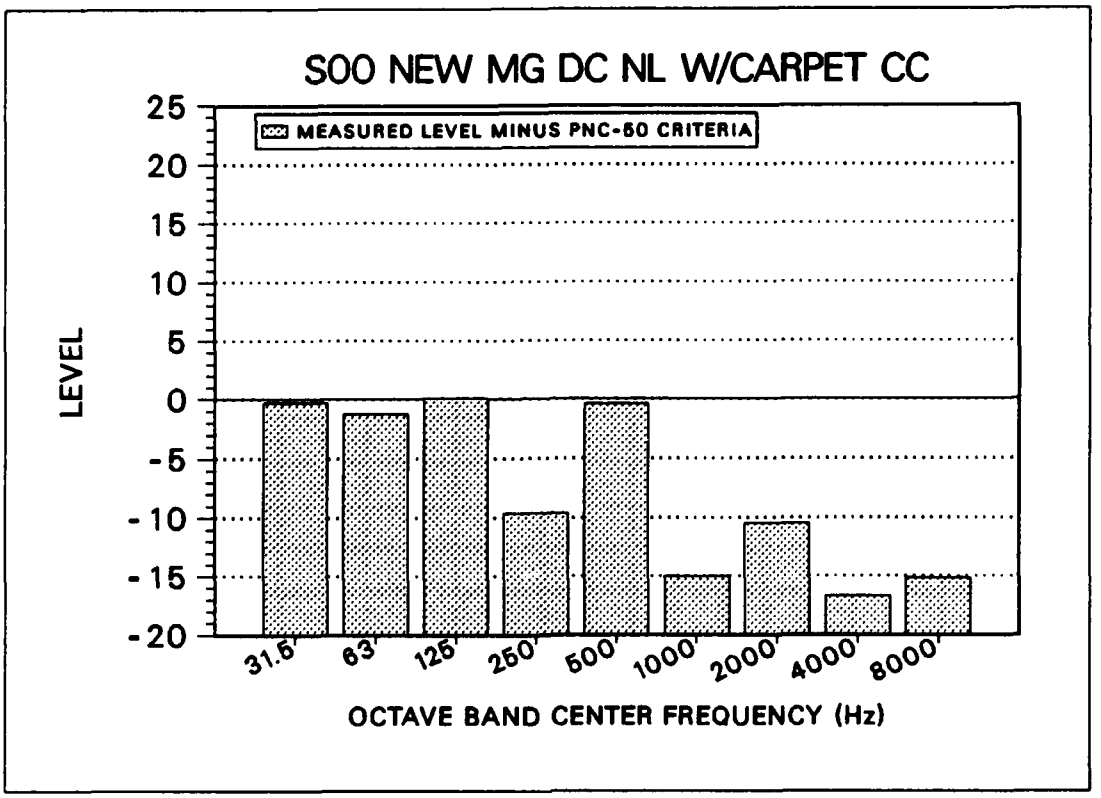
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	74.6	70	4.6
63	57.6	66	−8.4
125	57	62	−5
250	48.3	58	−9.6
500	60	54	6
1,000	36.4	50	−13.5
2,000	46.7	46	0.7
4,000	37.2	43	−5.7
8,000	33.9	43	−9.1



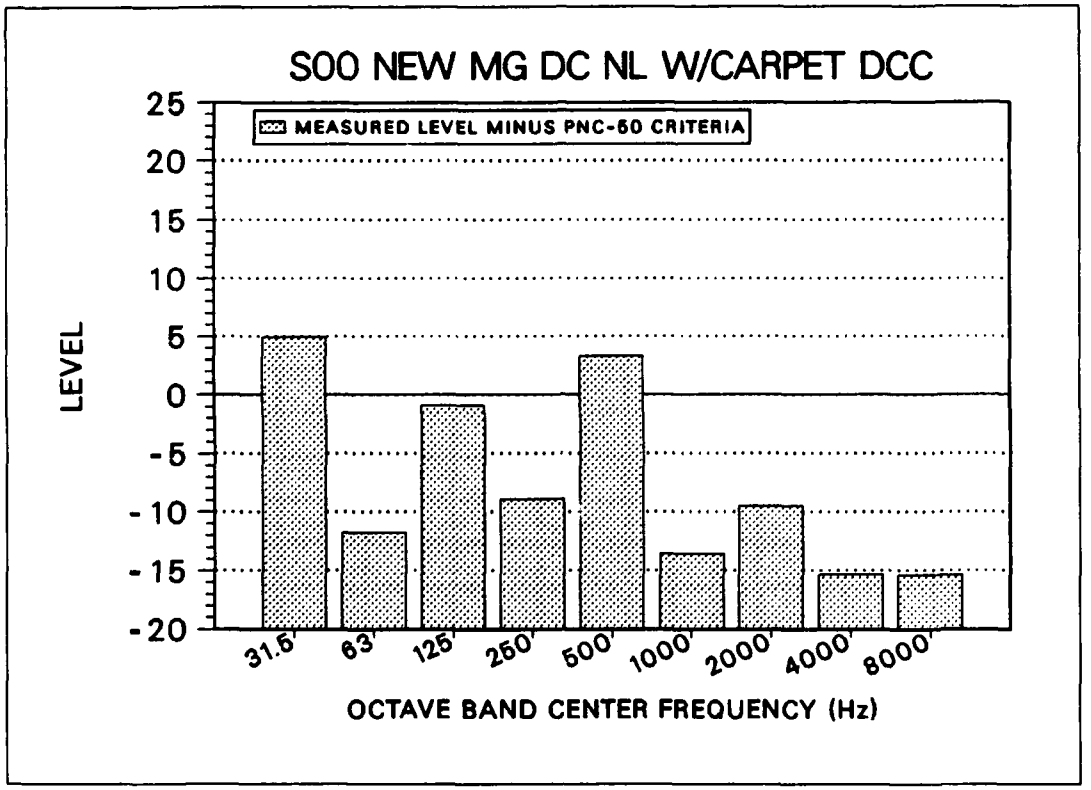
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	76.3	70	6.3
63	66.2	66	0.2
125	58.4	62	−3.6
250	50.1	58	−7.8
500	53.3	54	−0.7
1,000	39.1	50	−10.9
2,000	36.6	46	−9.4
4,000	26.6	43	−16.4
8,000	27.4	43	−15.6



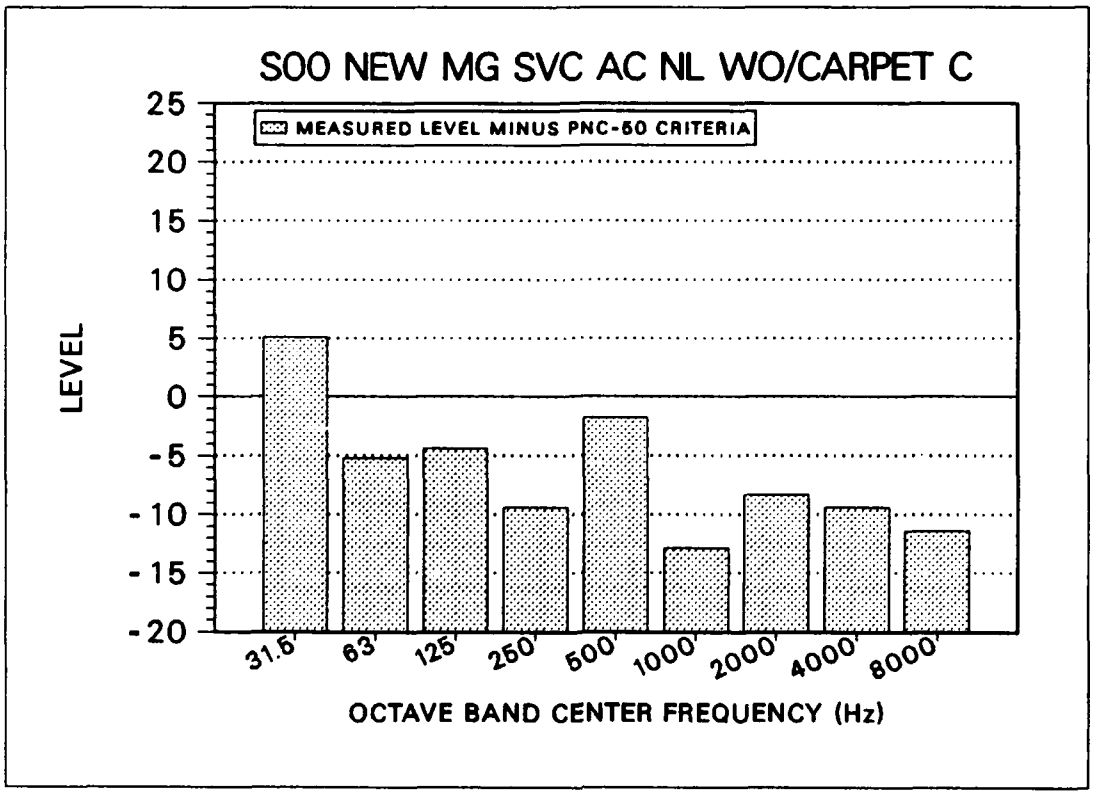
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	77.3	70	7.3
63	57.4	66	−8.6
125	60.1	62	−1.9
250	48.8	58	−9.2
500	49.6	54	−4.4
1,000	38.3	50	−11.7
2,000	37.5	46	−8.5
4,000	27.9	43	−15.1
8,000	27.2	43	−15.8



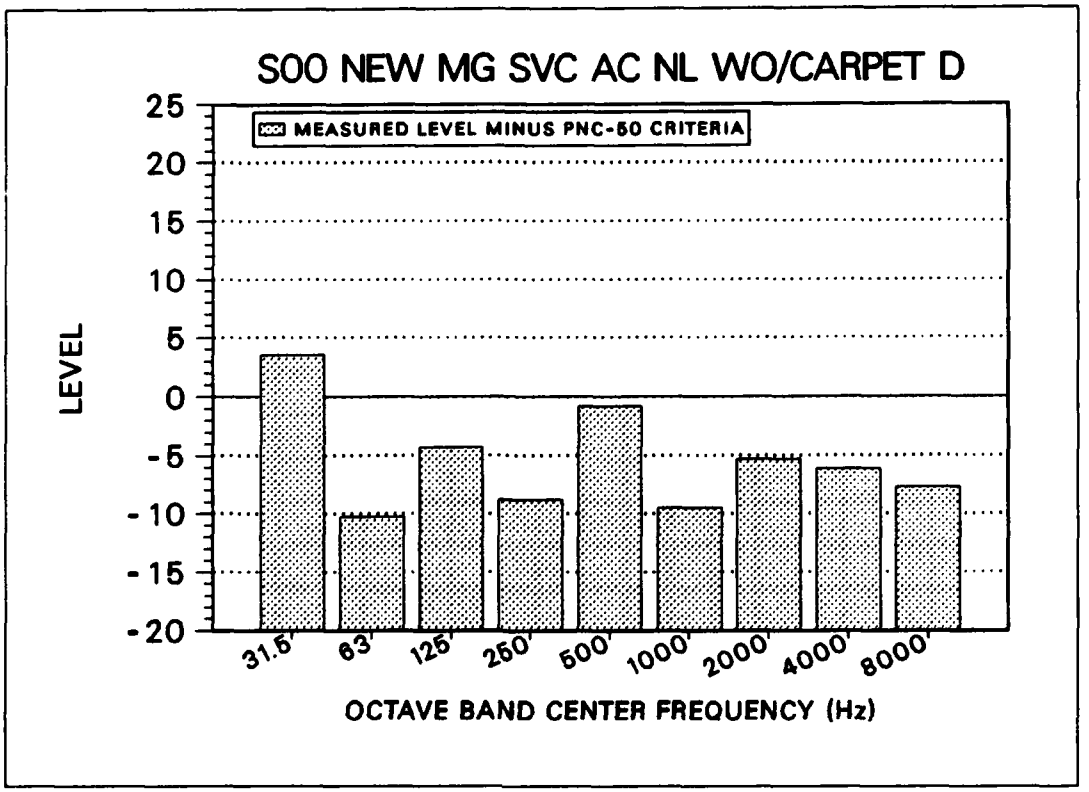
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	69.7	70	–0.3
63	64.8	66	–1.2
125	62.1	62	0.1
250	48.4	58	–9.6
500	53.6	54	–0.4
1,000	35	50	–15
2,000	35.5	46	–10.5
4,000	26.3	43	–16.7
8,000	27.8	43	–15.2



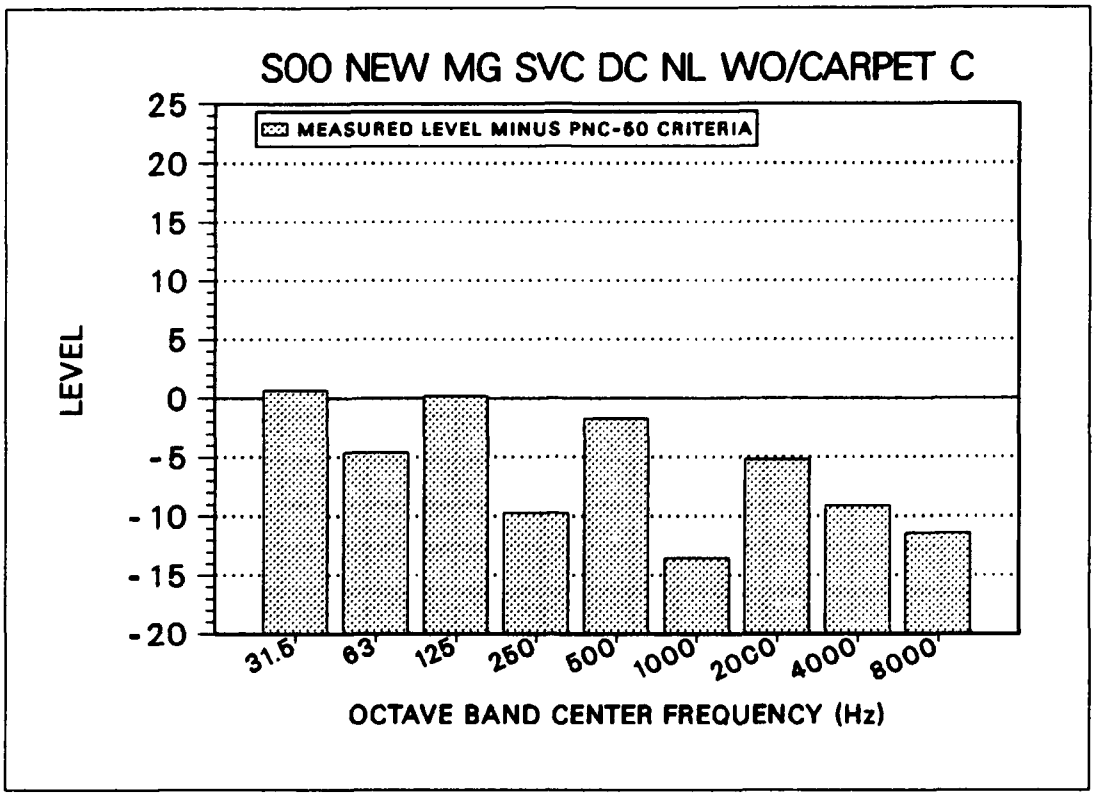
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	74.9	70	4.9
63	54.2	66	−11.8
125	61.1	62	−0.9
250	49.1	58	−8.9
500	57.3	54	3.3
1,000	36.4	50	−13.6
2,000	36.5	46	−9.5
4,000	27.7	43	−15.3
8,000	27.6	43	−15.4



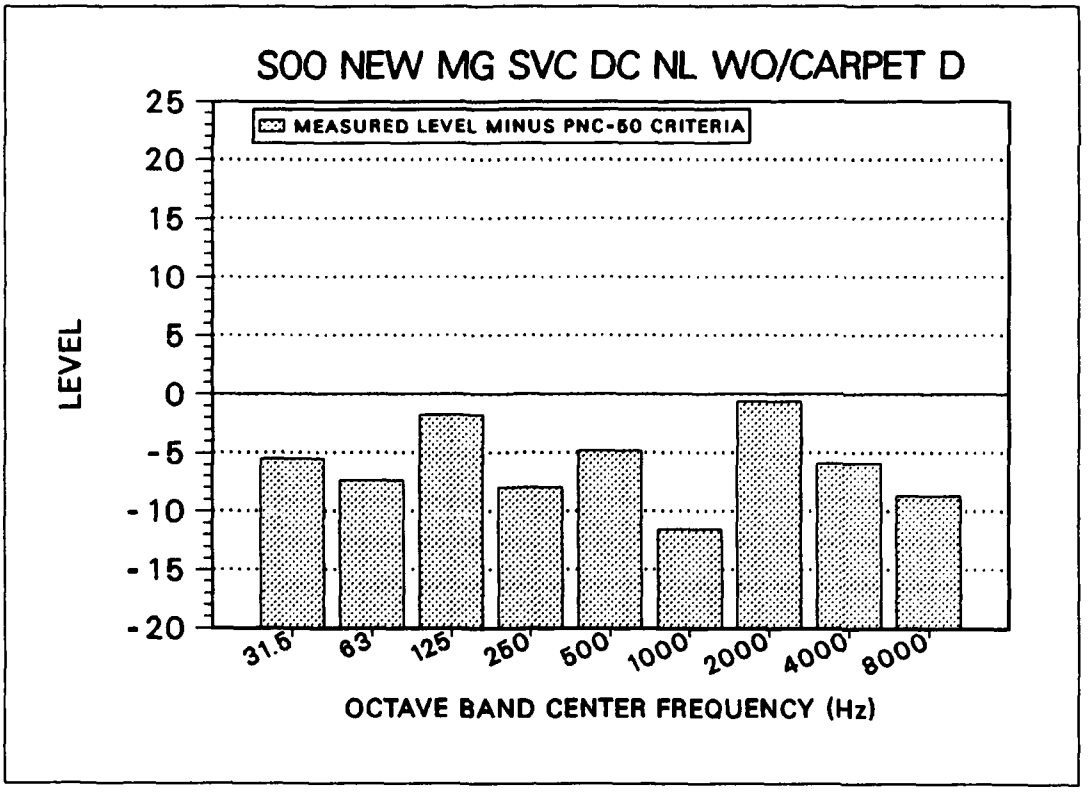
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	75	70	5.1
63	60.8	66	−5.2
125	57.6	62	−4.4
250	48.6	58	−9.4
500	52.2	54	−1.8
1,000	37.1	50	−12.9
2,000	37.7	46	−8.3
4,000	33.6	43	−9.4
8,000	31.5	43	−11.4



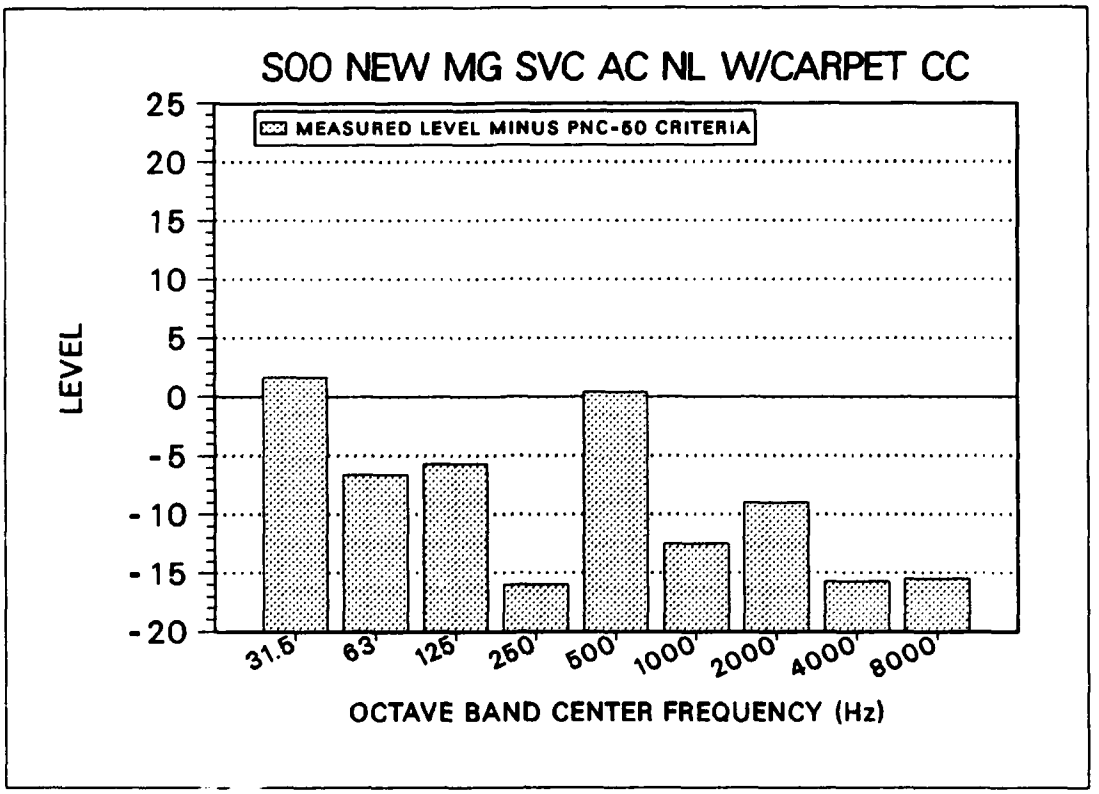
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	73.5	70	3.5
63	55.7	66	−10.3
125	57.6	62	−4.3
250	49.2	58	−8.8
500	53.2	54	−0.8
1,000	40.5	50	−9.5
2,000	40.7	46	−5.3
4,000	36.9	43	−6.1
8,000	35.3	43	−7.7



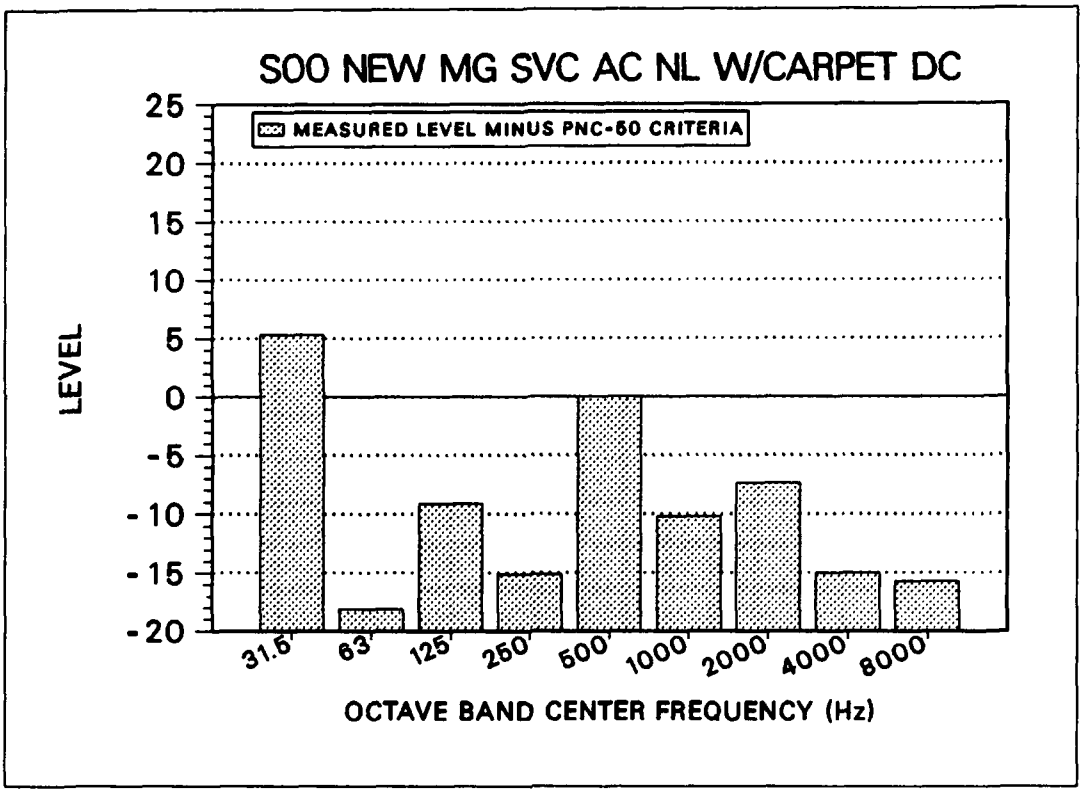
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	70.7	70	0.7
63	61.3	66	−4.6
125	62.2	62	0.2
250	48.3	58	−9.7
500	52.3	54	−1.7
1,000	36.5	50	−13.5
2,000	40.8	46	−5.2
4,000	33.9	43	−9.1
8,000	31.6	43	−11.4



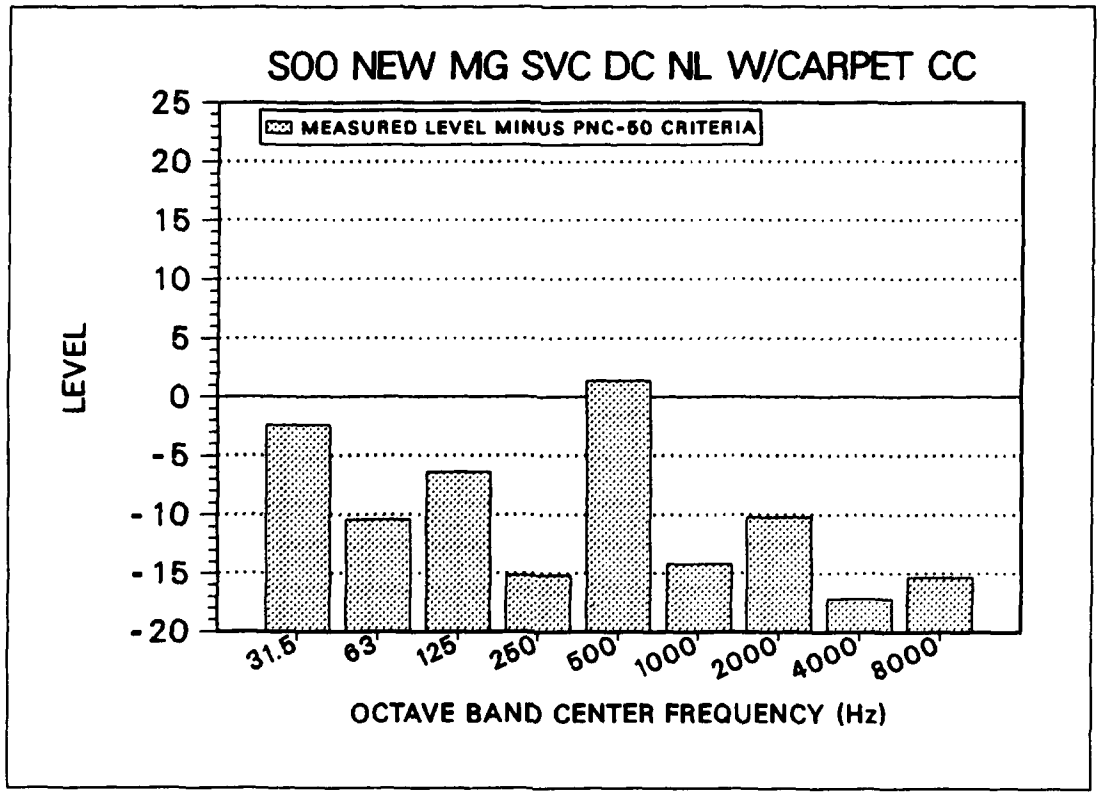
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	64.5	70	−5.5
63	58.5	66	−7.4
125	60.2	62	−1.8
250	49.9	58	−8
500	49.2	54	−4.8
1,000	38.4	50	−11.6
2,000	45.4	46	−0.6
4,000	37.1	43	−5.9
8,000	34.3	43	−8.7



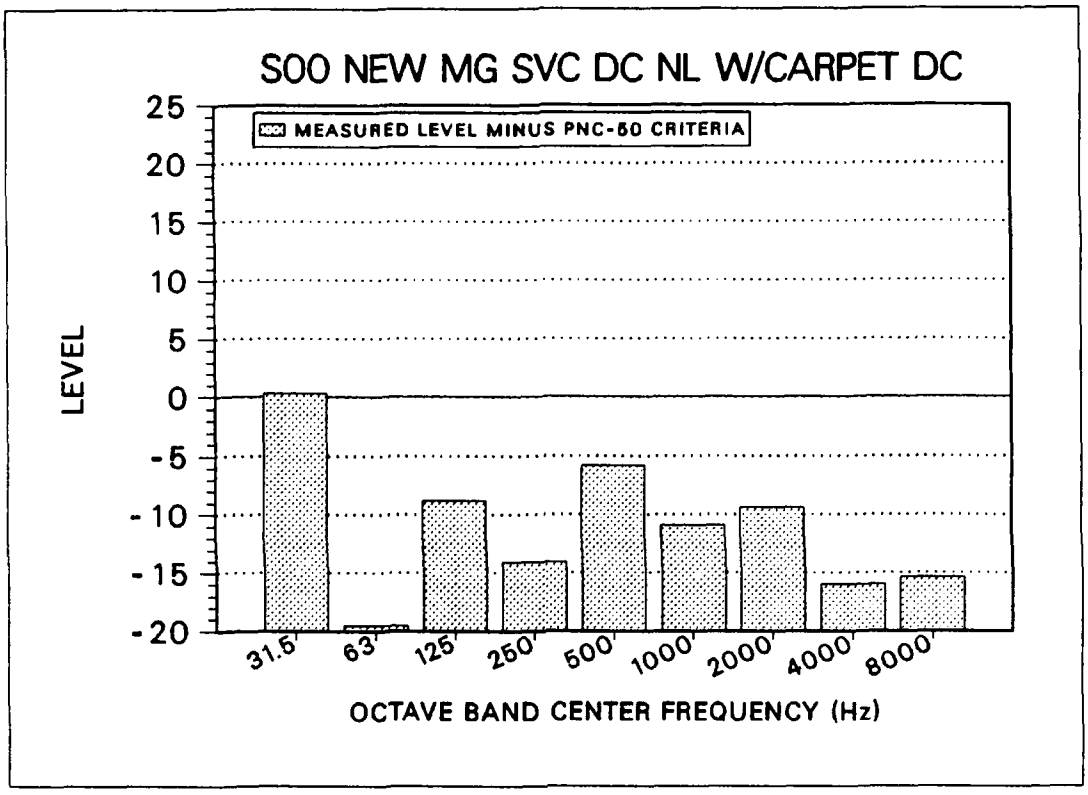
FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	71.6	70	1.7
63	59.4	66	−6.6
125	56.3	62	−5.7
250	42	58	−16
500	54.4	54	0.4
1,000	37.5	50	−12.5
2,000	37	46	−9
4,000	27.3	43	−15.7
8,000	27.4	43	−15.5



FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	75.3	70	5.3
63	47.9	66	−18.1
125	52.9	62	−9.1
250	42.9	58	−15.1
500	54	54	0
1,000	39.8	50	−10.2
2,000	38.6	46	−7.4
4,000	28	43	−15
8,000	27.3	43	−15.7



FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	67.6	70	−2.4
63	55.6	66	−10.4
125	55.6	62	−6.4
250	42.8	58	−15.2
500	55.4	54	1.4
1,000	35.8	50	−14.2
2,000	35.8	46	−10.2
4,000	25.8	43	−17.2
8,000	27.7	43	−15.3

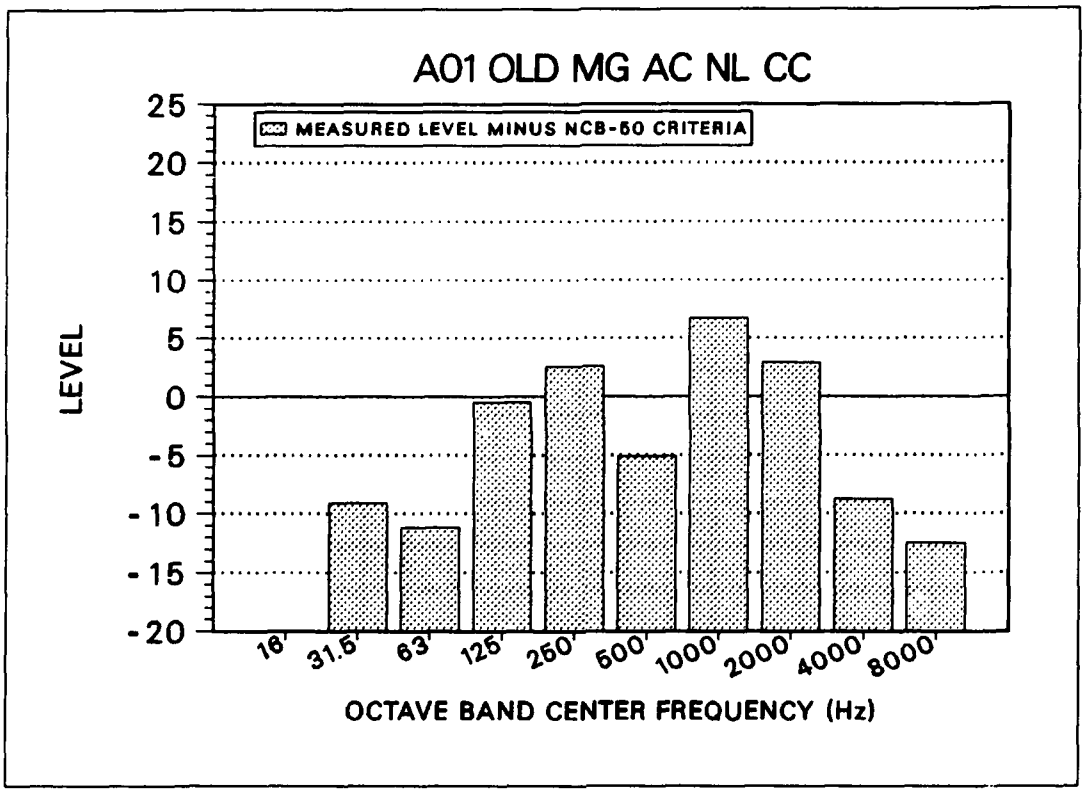


FREQ (Hz)	OCTAVE BAND SPL (dB)	PNC-50 CRITERIA (dB)	MEASURED LEVEL MINUS PNC-50 (dB)
31.5	70.3	70	0.3
63	46.5	66	−19.5
125	53.2	62	−8.8
250	43.9	58	−14.1
500	48.2	54	−5.8
1,000	39.1	50	−10.9
2,000	36.6	46	−9.4
4,000	27	43	−16
8,000	27.6	43	−15.4

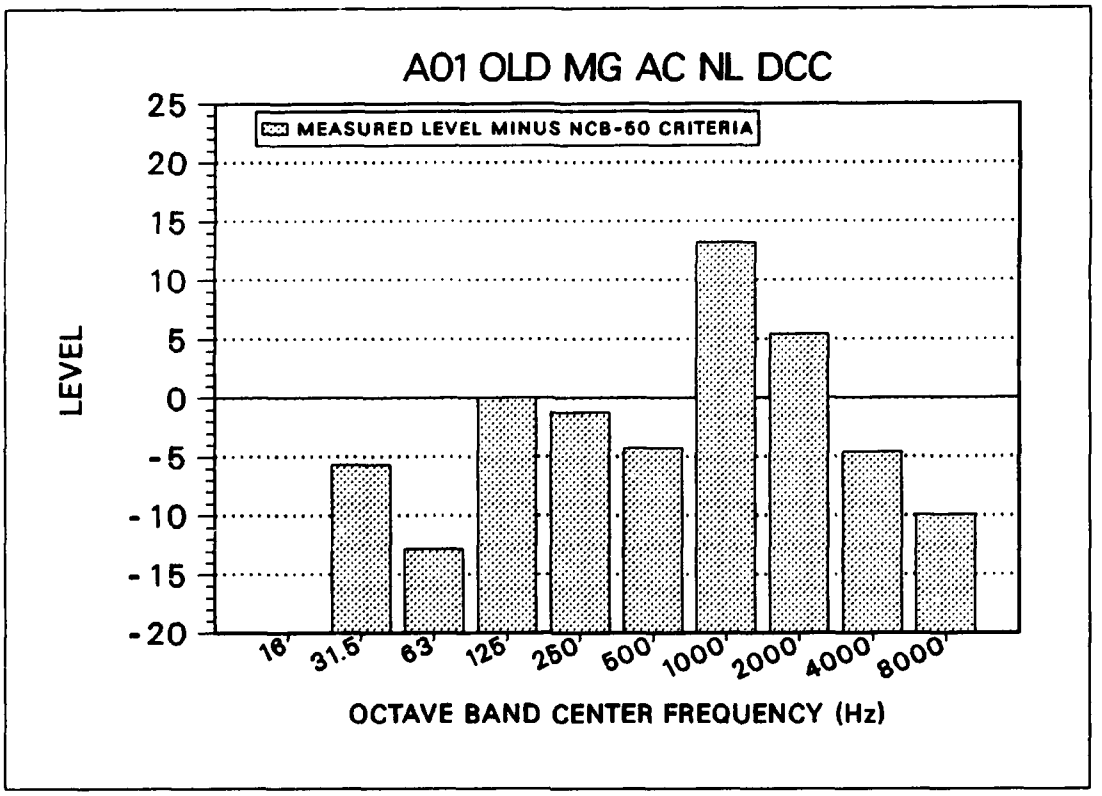
APPENDIX B

Performance Measurements at the Crew Positions

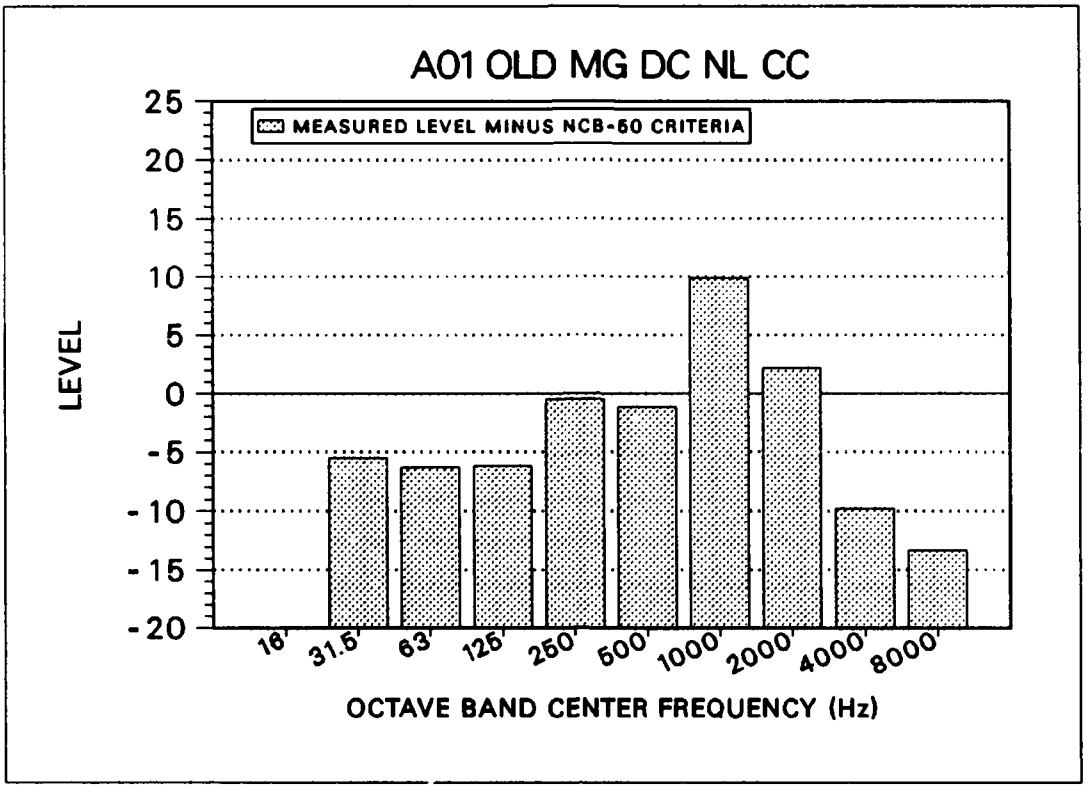
Measured Levels re. NCB-50



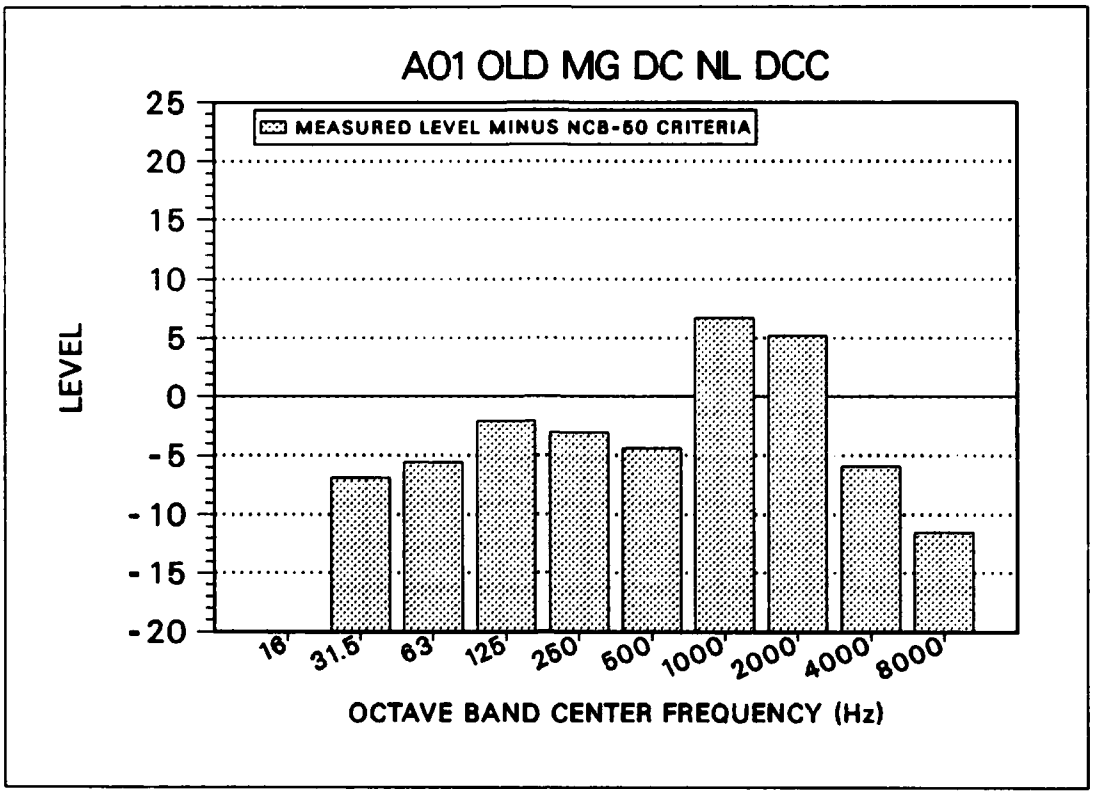
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	38.7	89	−50.3
31.5	69.9	79	−9.1
63	57.8	69	−11.2
125	61.5	62	−0.5
250	60.6	58	2.6
500	49.9	55	−5.1
1,000	58.7	52	6.7
2,000	51.9	49	2.9
4,000	37.2	46	−8.8
8,000	30.4	43	−12.5



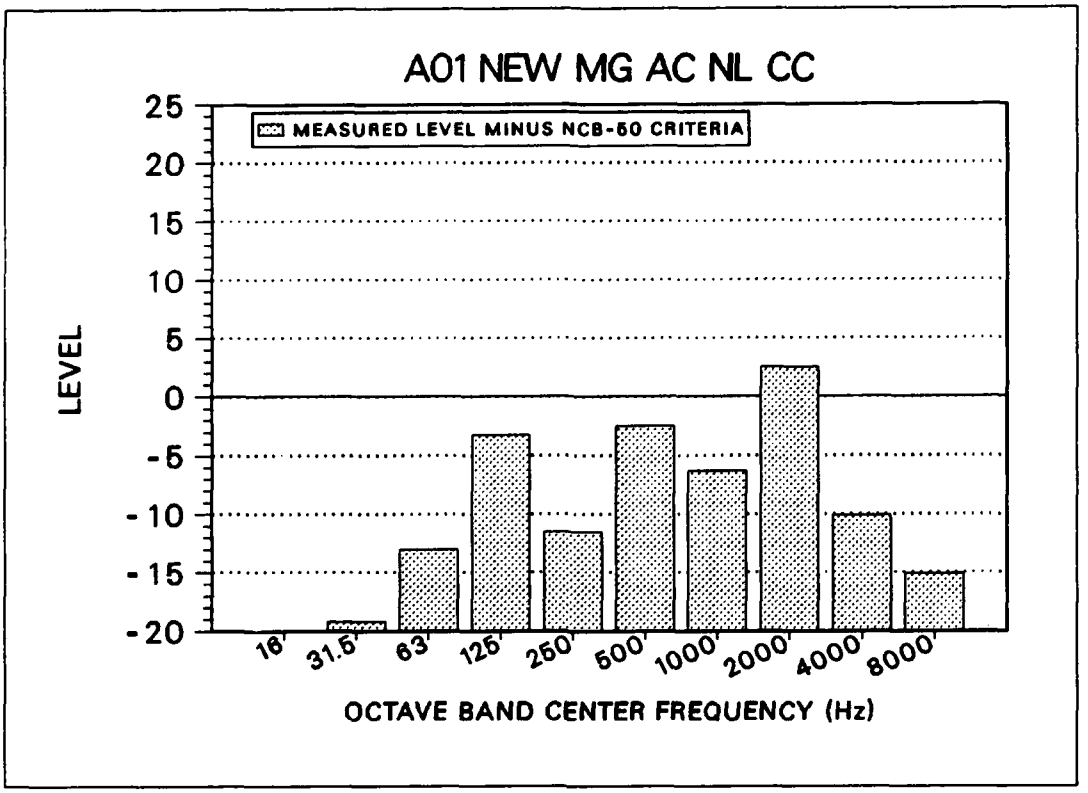
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	46.5	89	−42.5
31.5	73.3	79	−5.7
63	56.2	69	−12.8
125	62	62	0
250	56.8	58	−1.2
500	50.7	55	−4.3
1,000	65.2	52	13.2
2,000	54.4	49	5.4
4,000	41.4	46	−4.6
8,000	33.1	43	−9.9



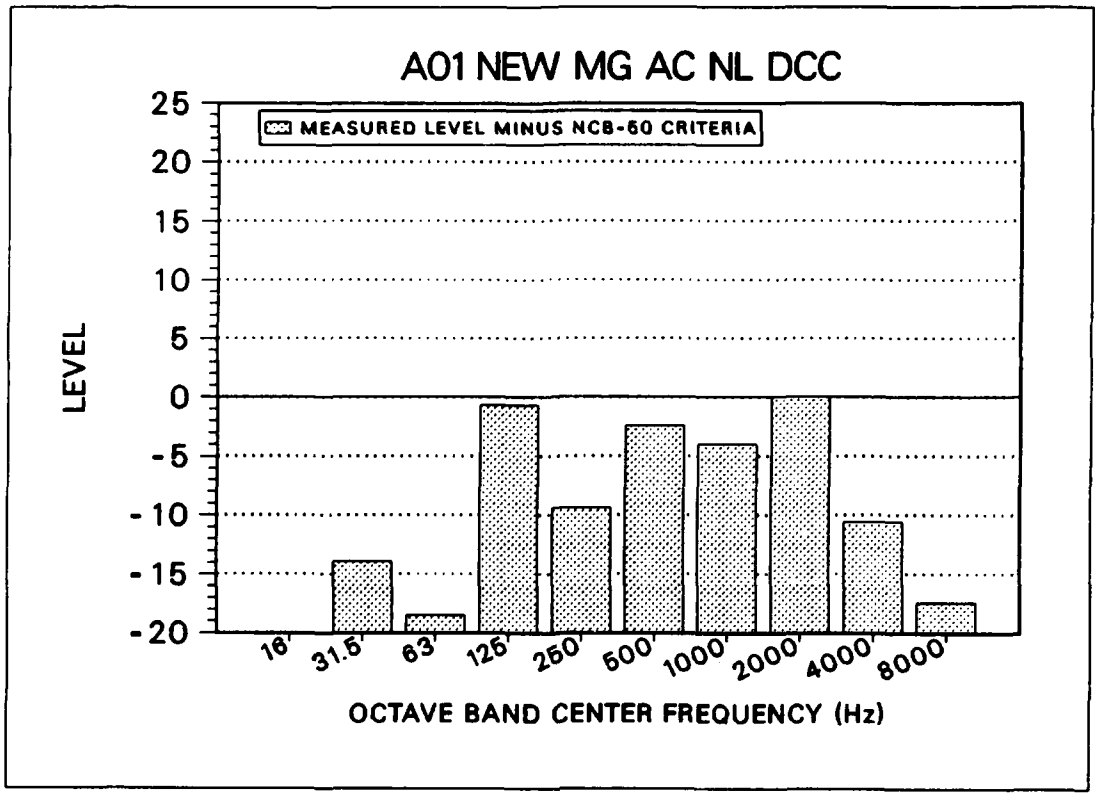
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	38.3	89	-50.7
31.5	73.4	79	-5.5
63	62.7	69	-6.3
125	55.8	62	-6.2
250	57.5	58	-0.5
500	53.8	55	-1.1
1,000	61.9	52	9.9
2,000	51.2	49	2.2
4,000	36.2	46	-9.8
8,000	29.7	43	-13.3



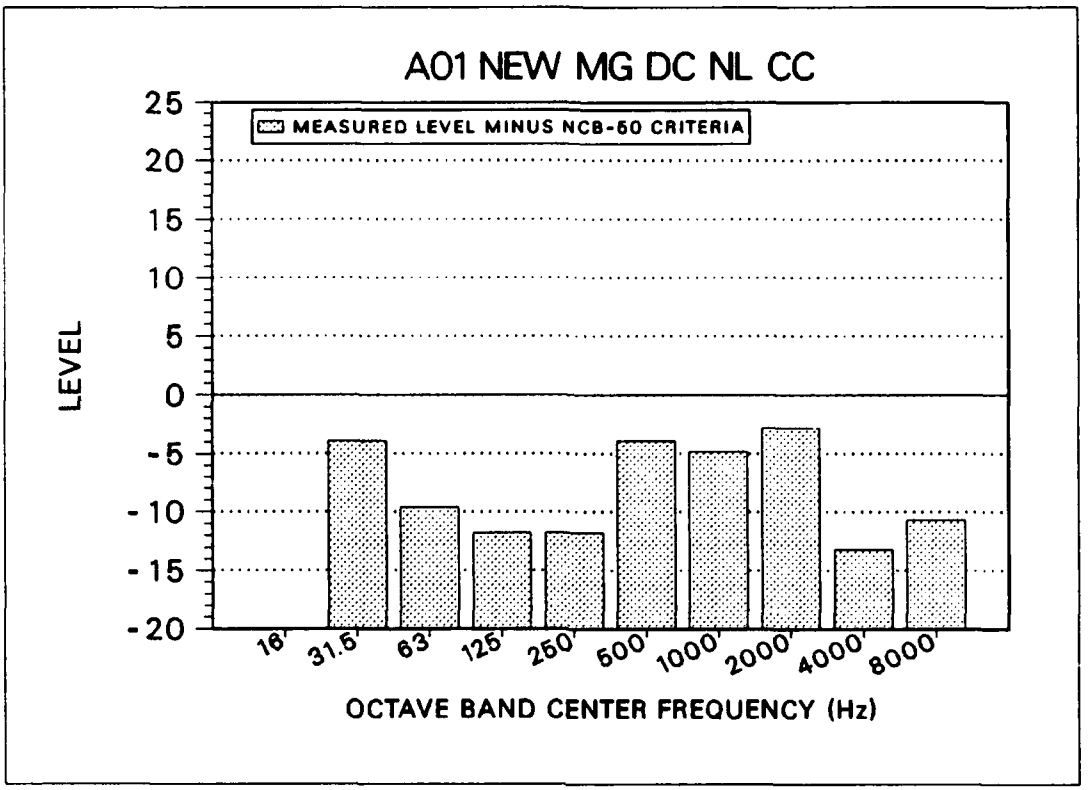
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	45.2	89	-43.8
31.5	72.1	79	-6.9
63	63.4	69	-5.6
125	59.9	62	-2.1
250	54.8	58	-3.1
500	50.6	55	-4.4
1,000	58.7	52	6.7
2,000	54.1	49	5.2
4,000	40.1	46	-5.9
8,000	31.5	43	-11.5



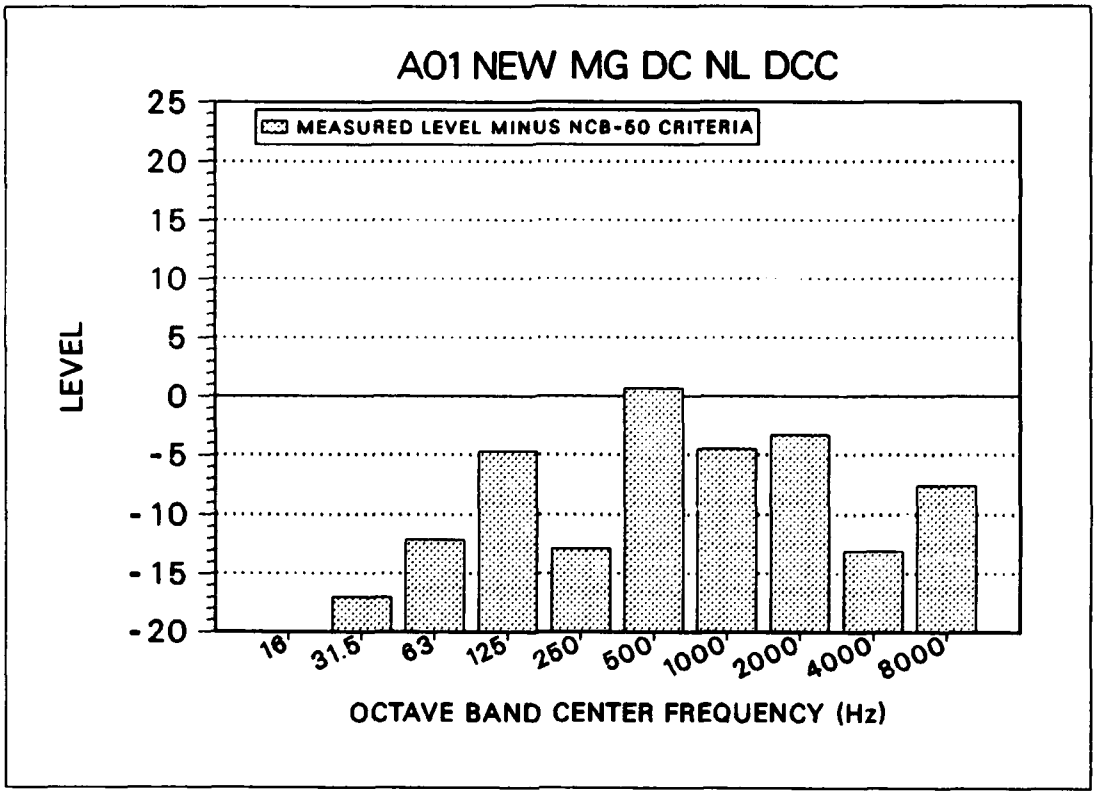
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	41	89	-48
31.5	59.8	79	-19.2
63	56	69	-13
125	58.7	62	-3.2
250	46.5	58	-11.5
500	52.5	55	-2.5
1,000	45.6	52	-6.3
2,000	51.5	49	2.5
4,000	35.9	46	-10.1
8,000	27.9	43	-15.1



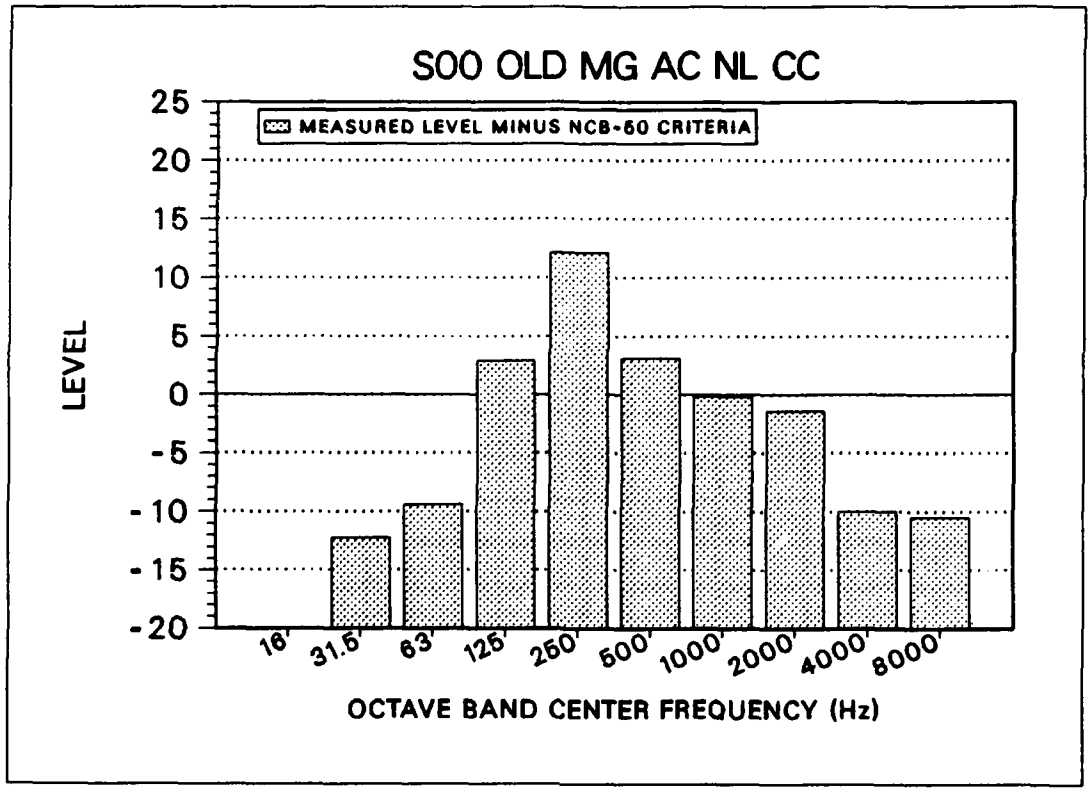
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	33.2	89	−55.8
31.5	65.1	79	−13.9
63	50.5	69	−18.5
125	61.3	62	−0.7
250	48.6	58	−9.4
500	52.6	55	−2.4
1,000	48	52	−4
2,000	49	49	0
4,000	35.4	46	−10.6
8,000	25.6	43	−17.4



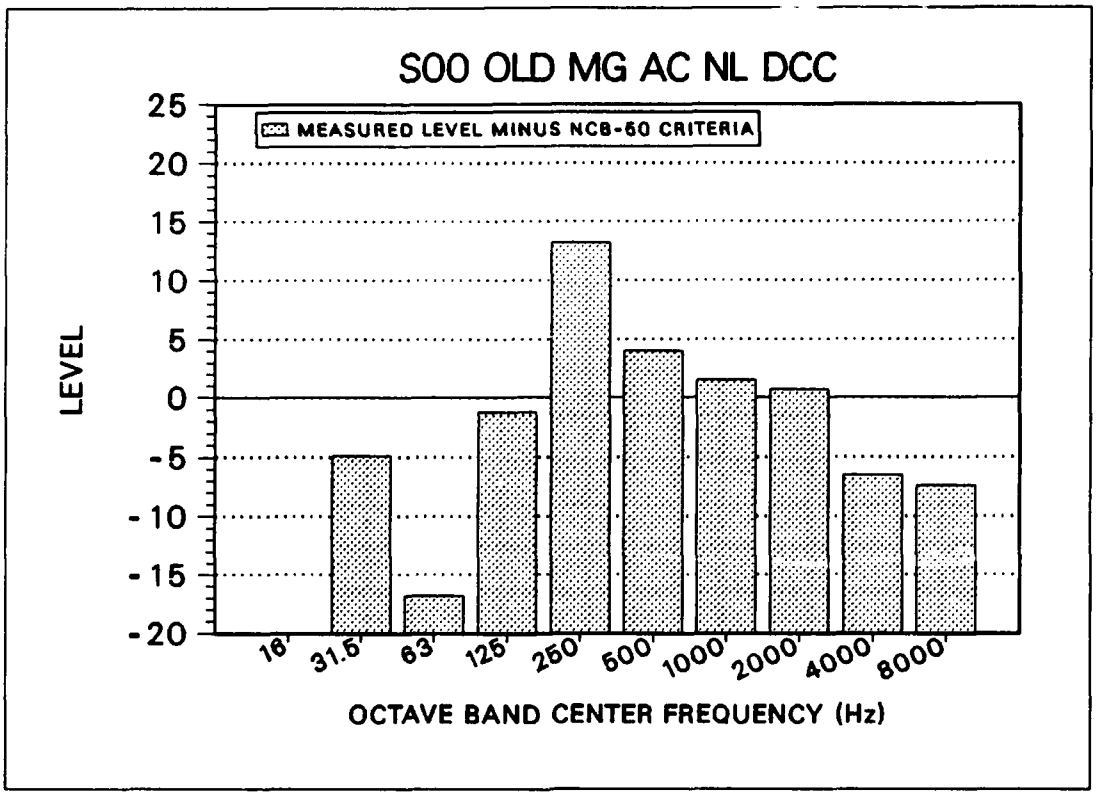
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	52.1	89	−36.9
31.5	75.1	79	−3.9
63	59.4	69	−9.6
125	50.2	62	−11.8
250	46.2	58	−11.8
500	51.1	55	−3.9
1,000	47.2	52	−4.8
2,000	46.2	49	−2.8
4,000	32.7	46	−13.2
8,000	32.3	43	−10.7



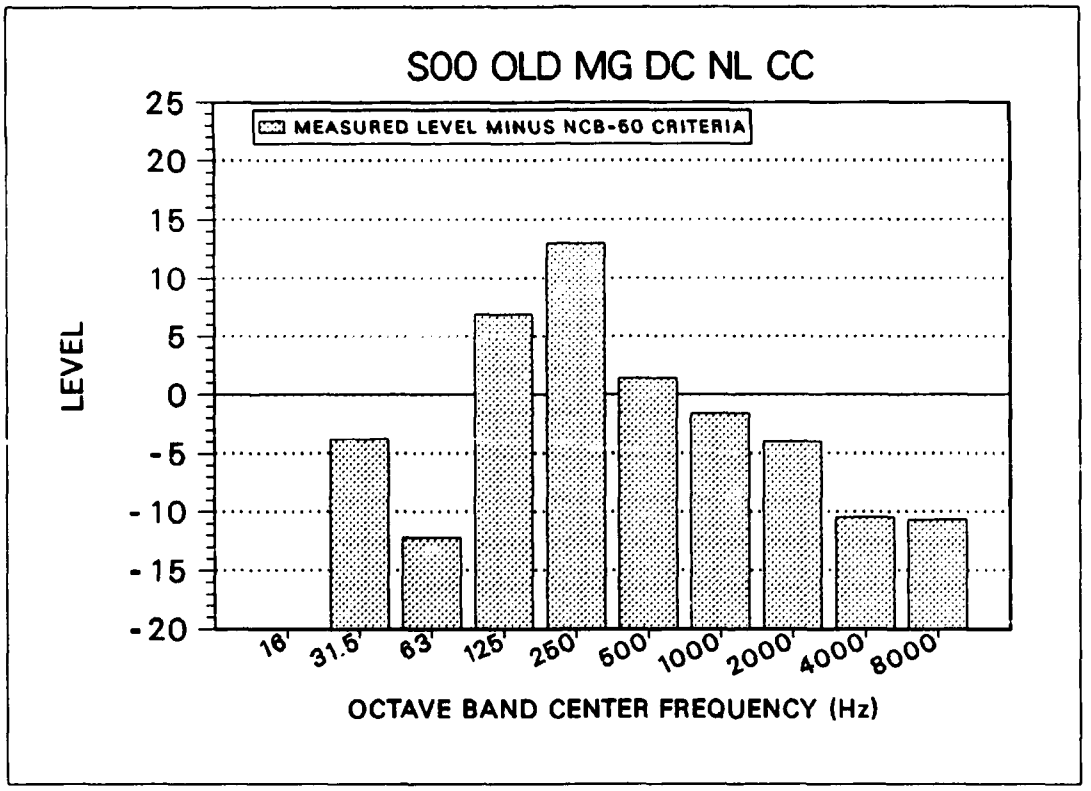
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	49.7	89	−39.3
31.5	62	79	−17
63	56.9	69	−12.1
125	57.3	62	−4.7
250	45.1	58	−12.9
500	55.7	55	0.7
1,000	47.5	52	−4.5
2,000	45.7	49	−3.3
4,000	32.9	46	−13.1
8,000	35.4	43	−7.6



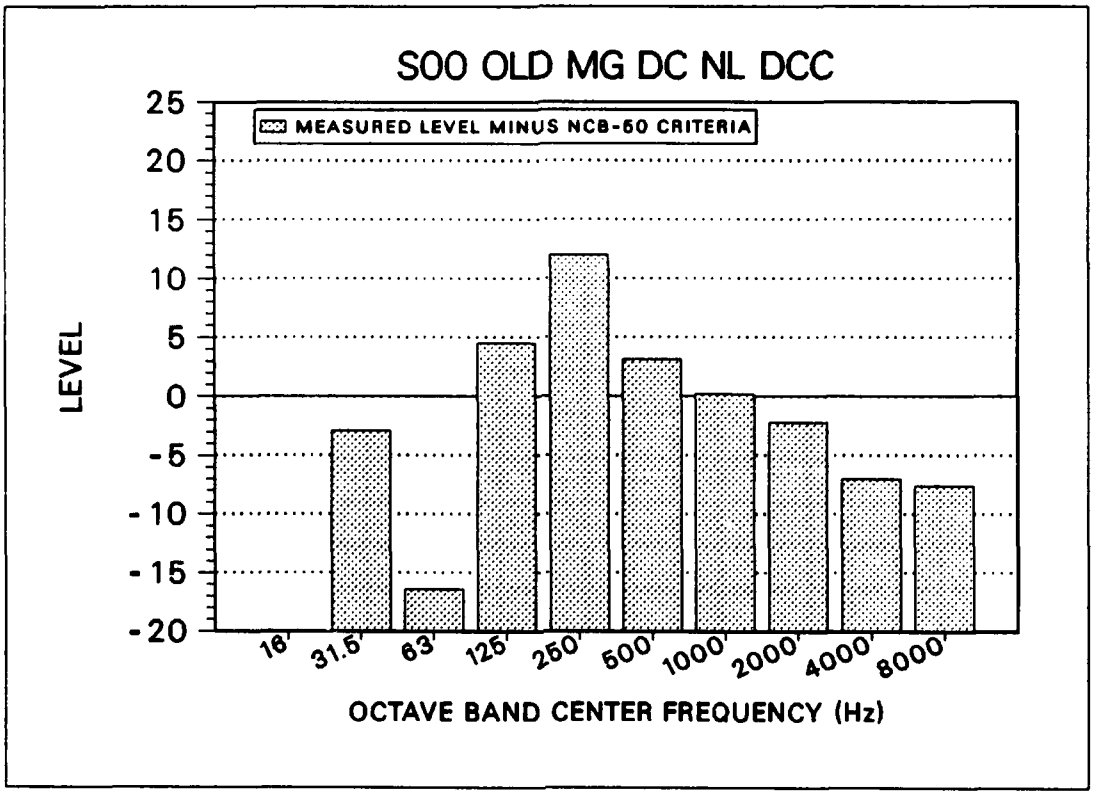
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	52.4	89	–36.6
31.5	66.8	79	–12.2
63	59.5	69	–9.4
125	64.9	62	2.9
250	70.1	58	12.1
500	58.1	55	3.1
1,000	51.9	52	–0.1
2,000	47.6	49	–1.4
4,000	36	46	–10
8,000	32.5	43	–10.5



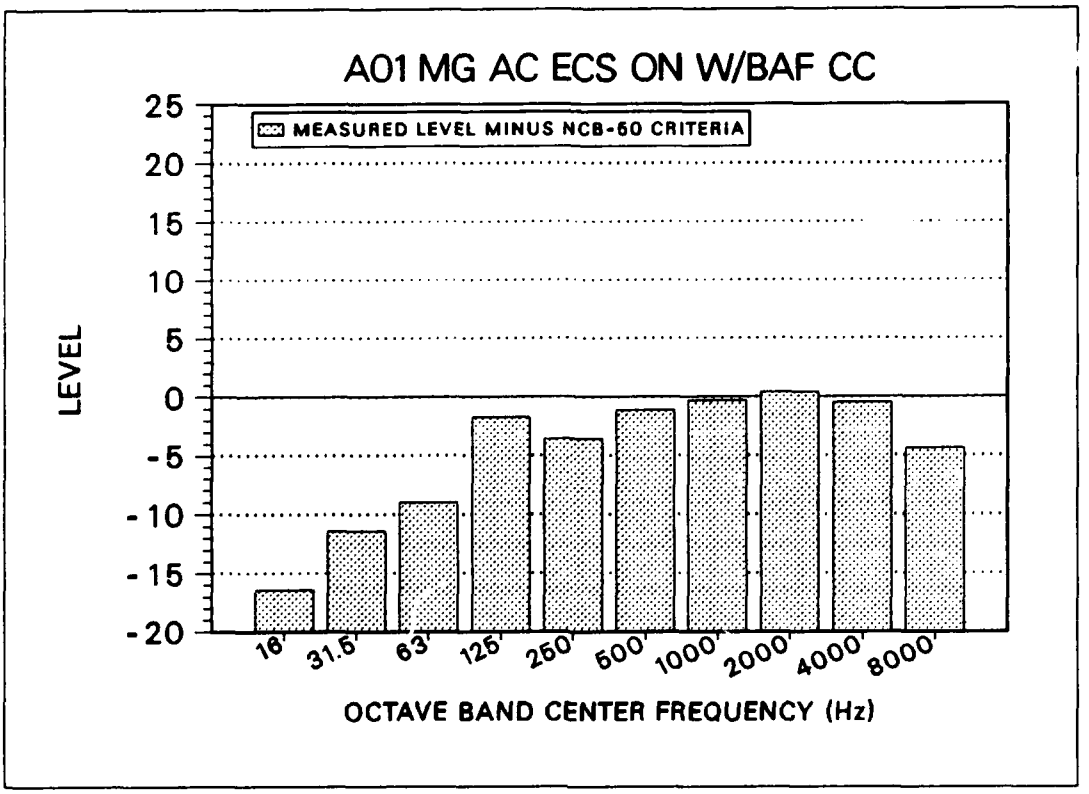
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	51	89	−38
31.5	74.1	79	−4.9
63	52.2	69	−16.8
125	60.8	62	−1.2
250	71.2	58	13.2
500	59	55	4
1,000	53.5	52	1.5
2,000	49.7	49	0.7
4,000	39.5	46	−6.5
8,000	35.6	43	−7.4



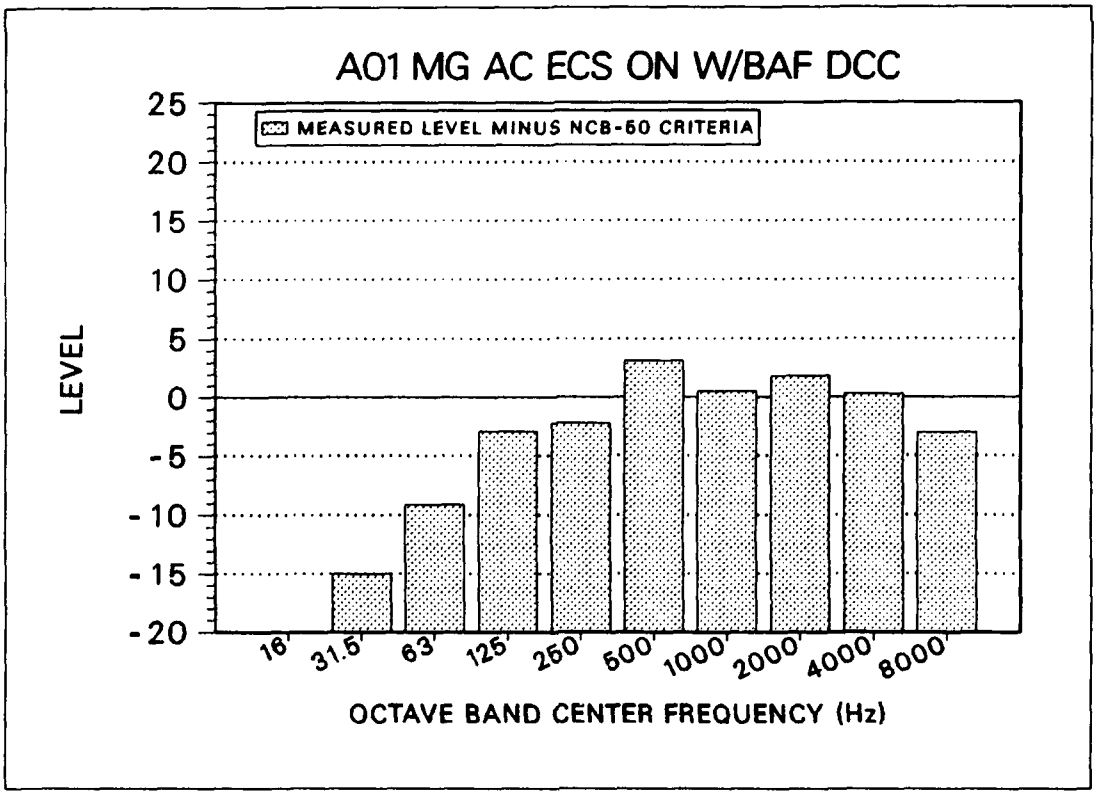
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	52.1	89	−36.9
31.5	75.1	79	−3.8
63	56.8	69	−12.2
125	68.9	62	6.9
250	71	58	13
500	56.4	55	1.4
1,000	50.4	52	−1.6
2,000	45	49	−4
4,000	35.5	46	−10.5
8,000	32.3	43	−10.7



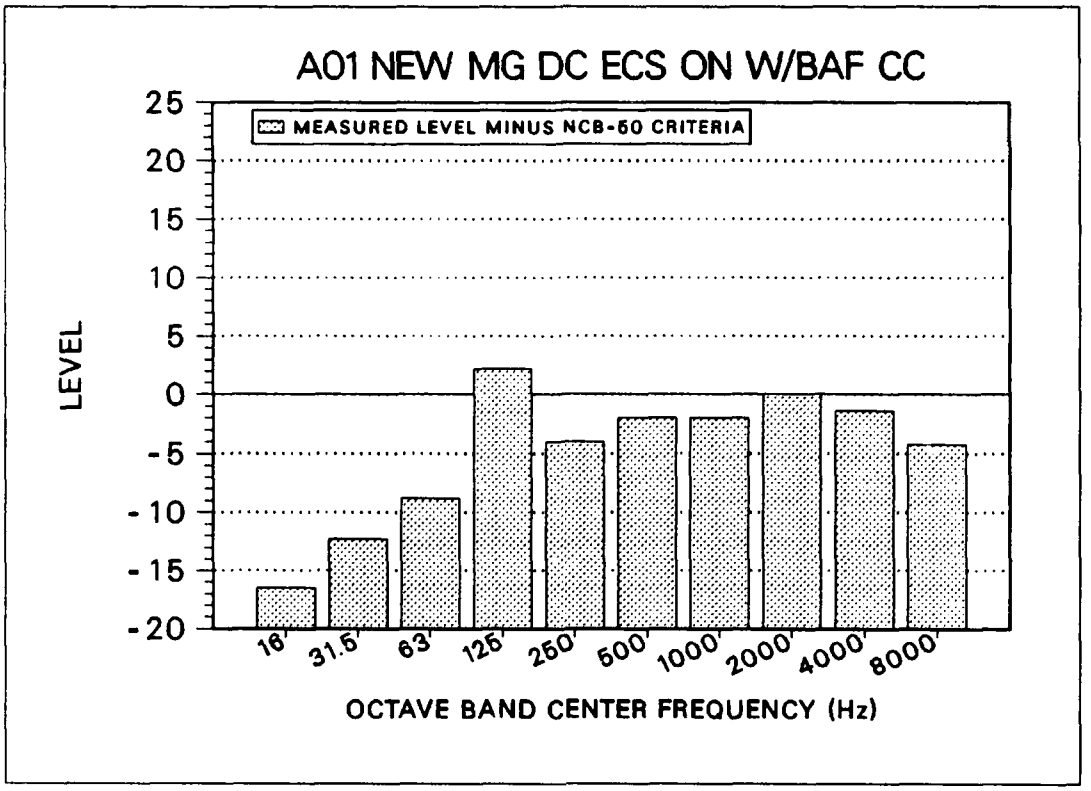
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	50.8	89	−38.2
31.5	76.1	79	−2.9
63	52.5	69	−16.4
125	66.5	62	4.5
250	70	58	12
500	58.1	55	3.1
1,000	52.2	52	0.2
2,000	46.8	49	−2.2
4,000	39	46	−7
8,000	35.4	43	−7.6



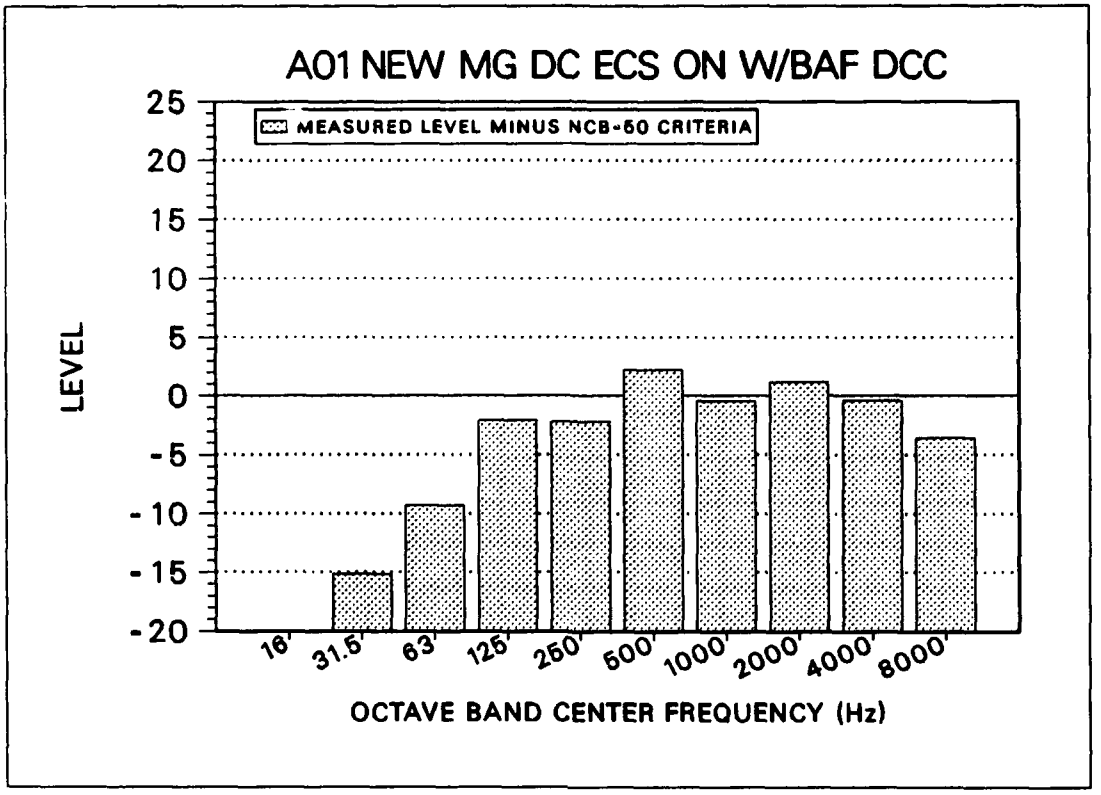
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	72.6	89	−16.4
31.5	67.6	79	−11.4
63	60	69	−9
125	60.3	62	−1.7
250	54.4	58	−3.6
500	53.9	55	−1.1
1,000	51.7	52	−0.3
2,000	49.4	49	0.4
4,000	45.5	46	−0.5
8,000	38.6	43	−4.4



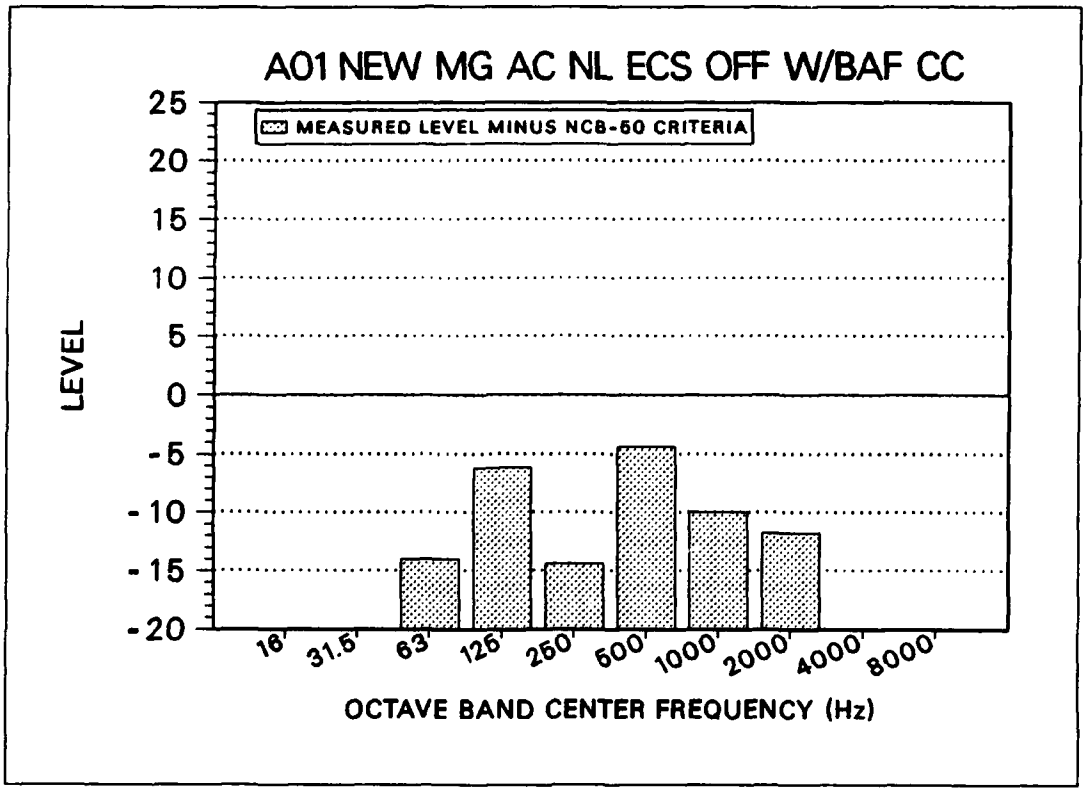
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	63.9	89	−25.1
31.5	64	79	−15
63	59.9	69	−9.1
125	59.1	62	−2.9
250	55.8	58	−2.2
500	58.1	55	3.1
1,000	52.4	52	0.5
2,000	50.8	49	1.8
4,000	46.3	46	0.3
8,000	40	43	−3



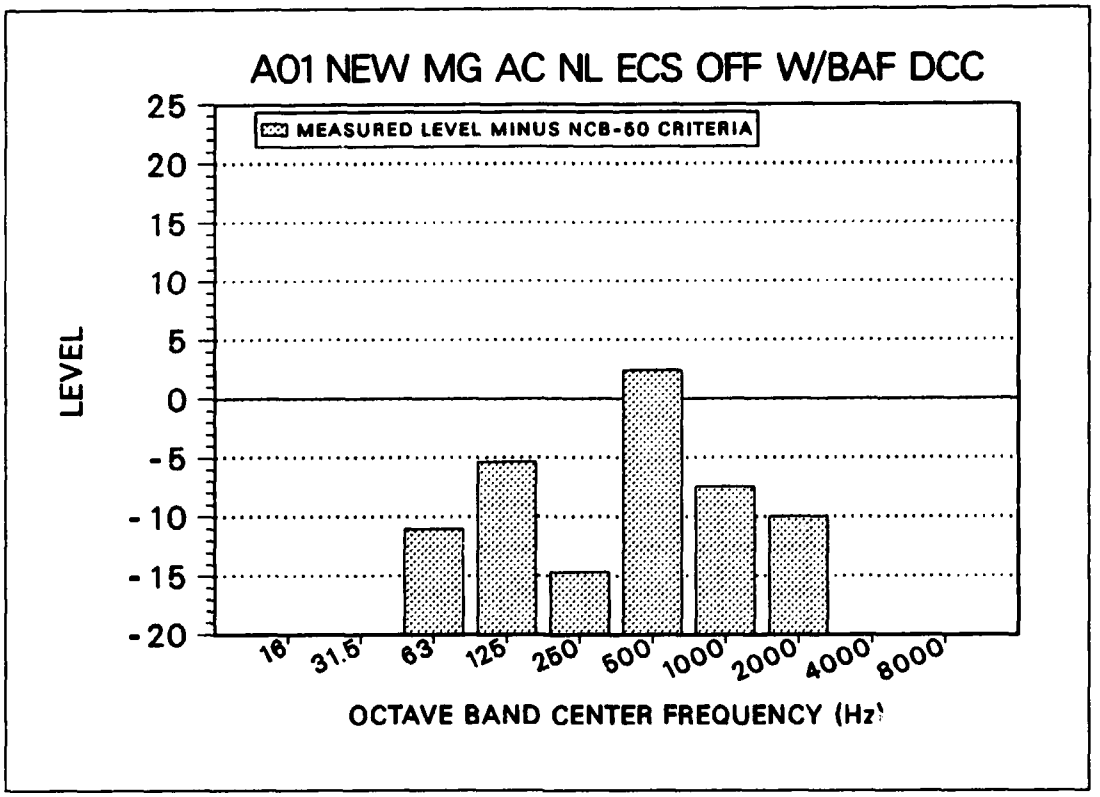
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	72.5	89	−16.5
31.5	66.6	79	−12.3
63	60.2	69	−8.8
125	64.2	62	2.2
250	54	58	−4
500	53	55	−2
1,000	50	52	−2
2,000	49	49	0
4,000	44.6	46	−1.4
8,000	38.8	43	−4.2



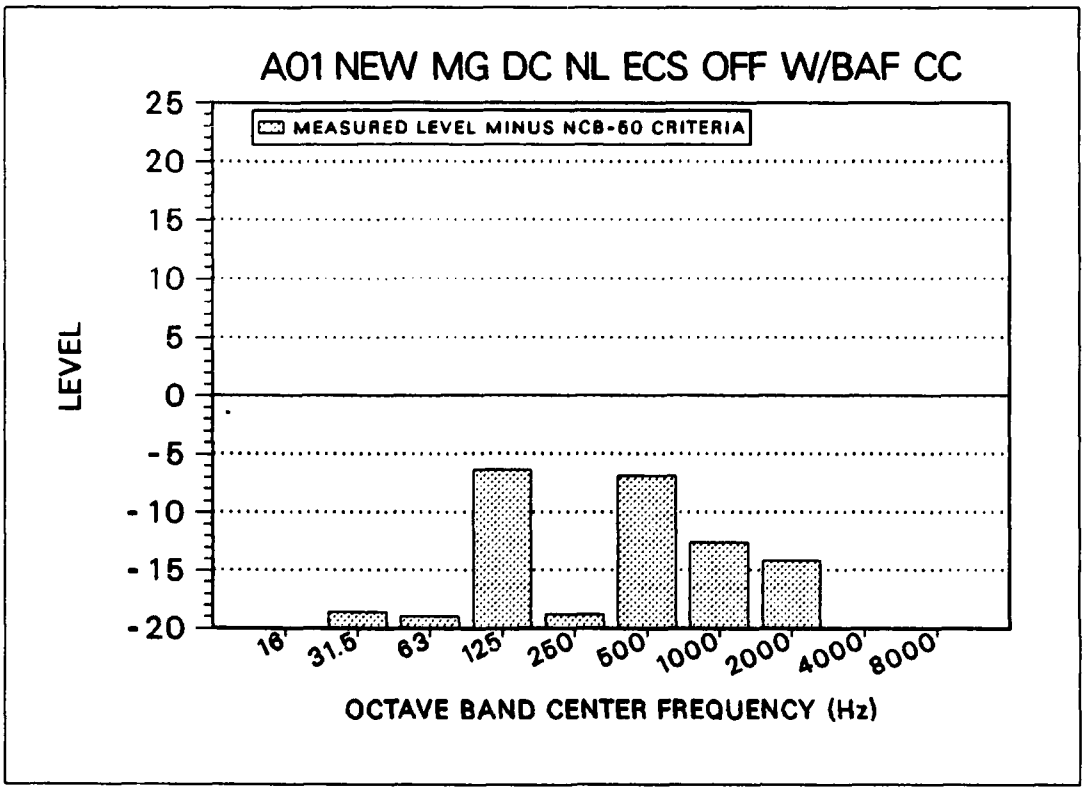
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	63.9	89	−25.1
31.5	63.7	79	−15.2
63	59.7	69	−9.3
125	59.9	62	−2.1
250	55.8	58	−2.2
500	57.2	55	2.2
1,000	51.4	52	−0.5
2,000	50.1	49	1.2
4,000	45.6	46	−0.4
8,000	39.4	43	−3.6



FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	37.8	89	−51.2
31.5	58.3	79	−20.7
63	55	69	−14
125	55.8	62	−6.2
250	43.6	58	−14.4
500	50.6	55	−4.4
1,000	42	52	−10
2,000	37.2	49	−11.8
4,000	22	46	−24
8,000	20.4	43	−22.5

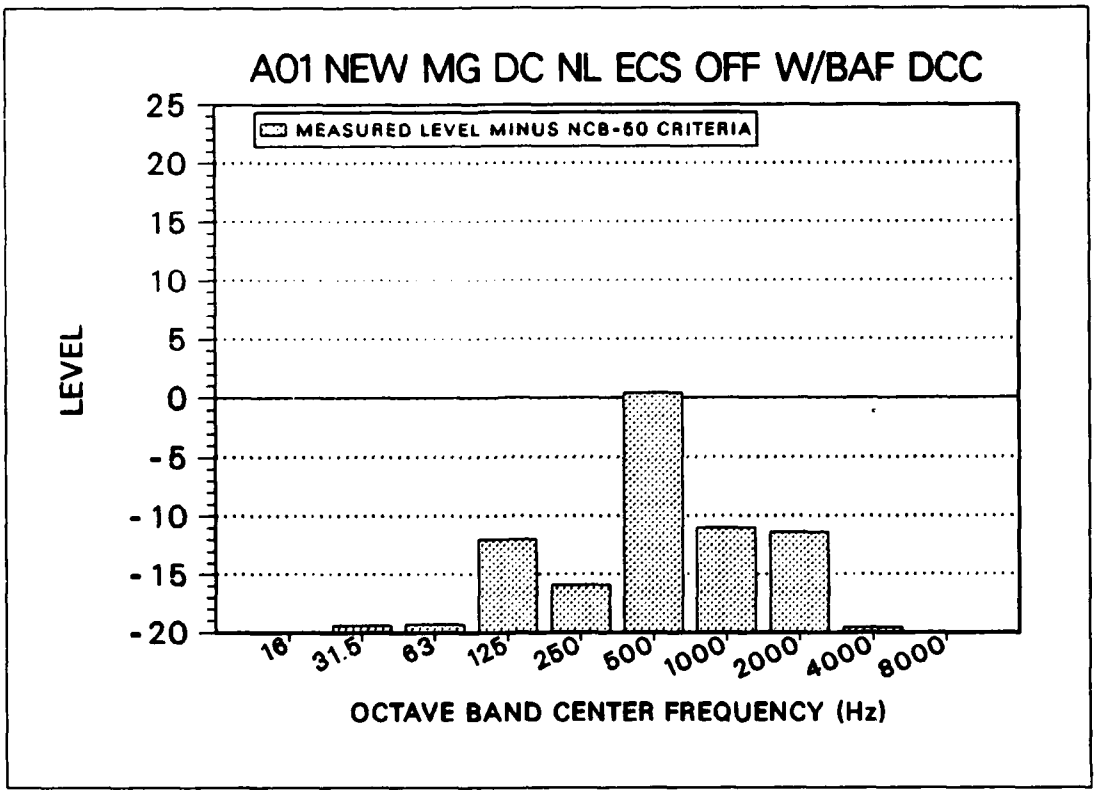


FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-60 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-60 (dB)
16	35	89	−54
31.5	58	79	−21
63	58	69	−11
125	56.6	62	−5.4
250	43.3	58	−14.7
500	57.4	55	2.4
1,000	44.5	52	−7.5
2,000	39	49	−10
4,000	25.6	46	−20.4
8,000	21.7	43	−21.3



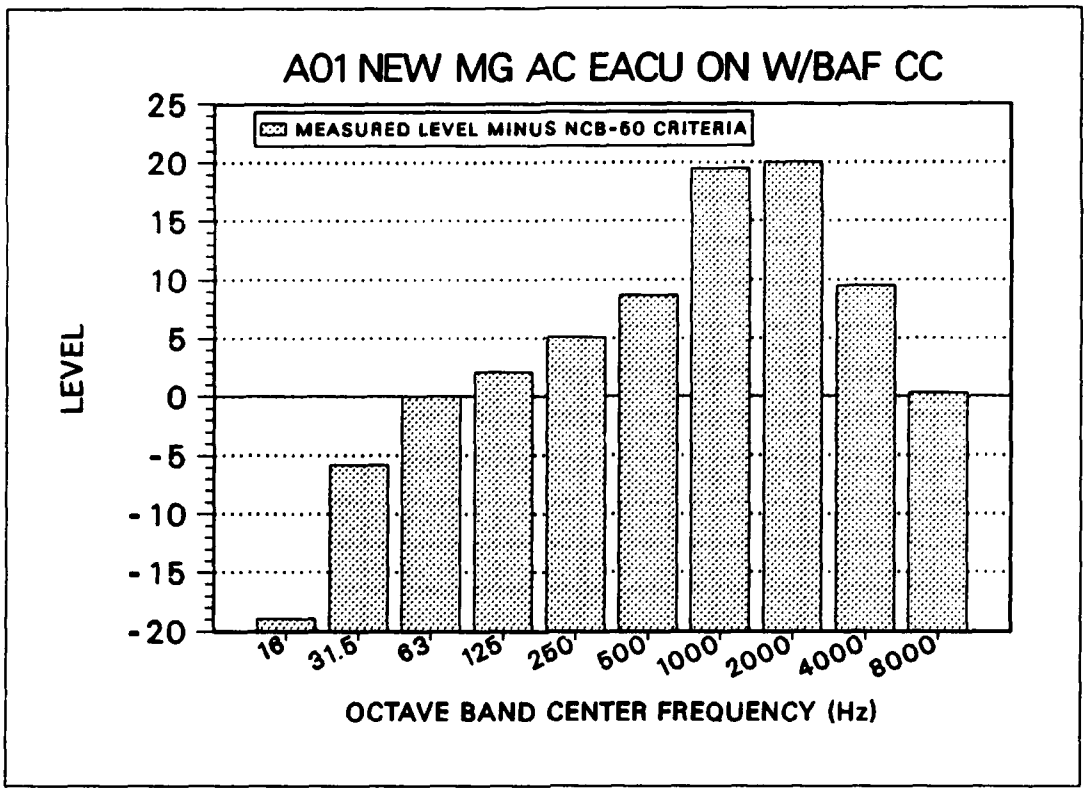
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	40.5	89	-48.5
31.5	60.4	79	-18.6
63	50	69	-19
125	55.6	62	-6.4
250	39.2	58	-18.8
500	48.1	55	-6.9
1,000	39.3	52	-12.6
2,000	34.8	49	-14.2
4,000	25.5	46	-20.5
8,000	****	43	****

**** SPL LESS THAN 10 dB ABOVE NOISE FLOOR AT THIS FREQUENCY

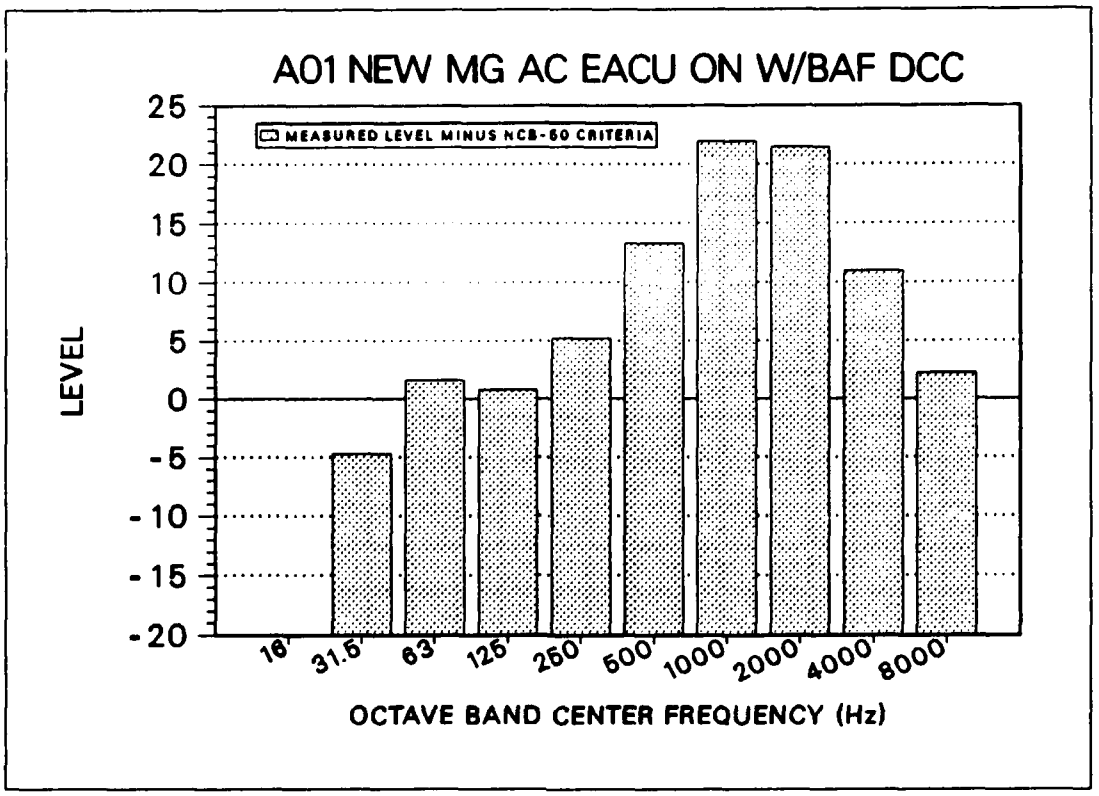


FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-60 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-60 (dB)
16	38.8	89	−50.2
31.5	59.6	79	−19.4
63	49.7	69	−19.3
125	50	62	−12
250	42.1	58	−15.9
500	55.3	55	0.4
1,000	41	52	−11
2,000	37.6	49	−11.4
4,000	26.4	46	−19.6
8,000	****	43	****

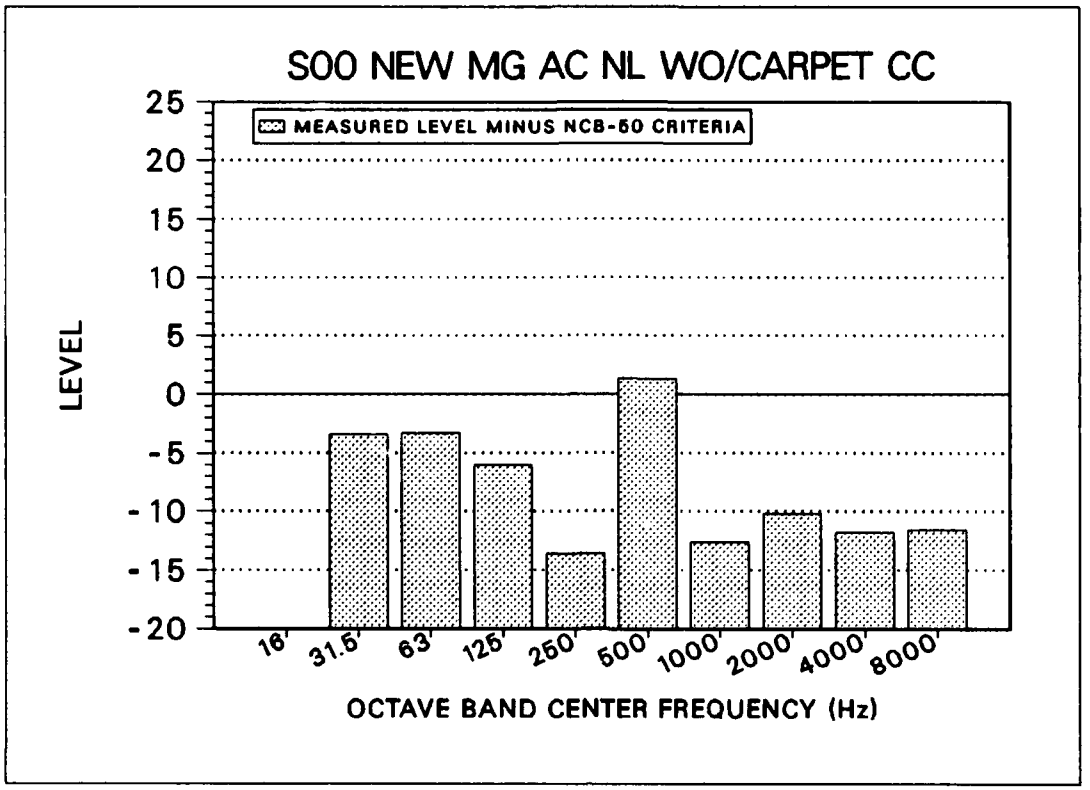
**** SPL LESS THAN 10 dB ABOVE NOISE FLOOR AT THIS FREQUENCY



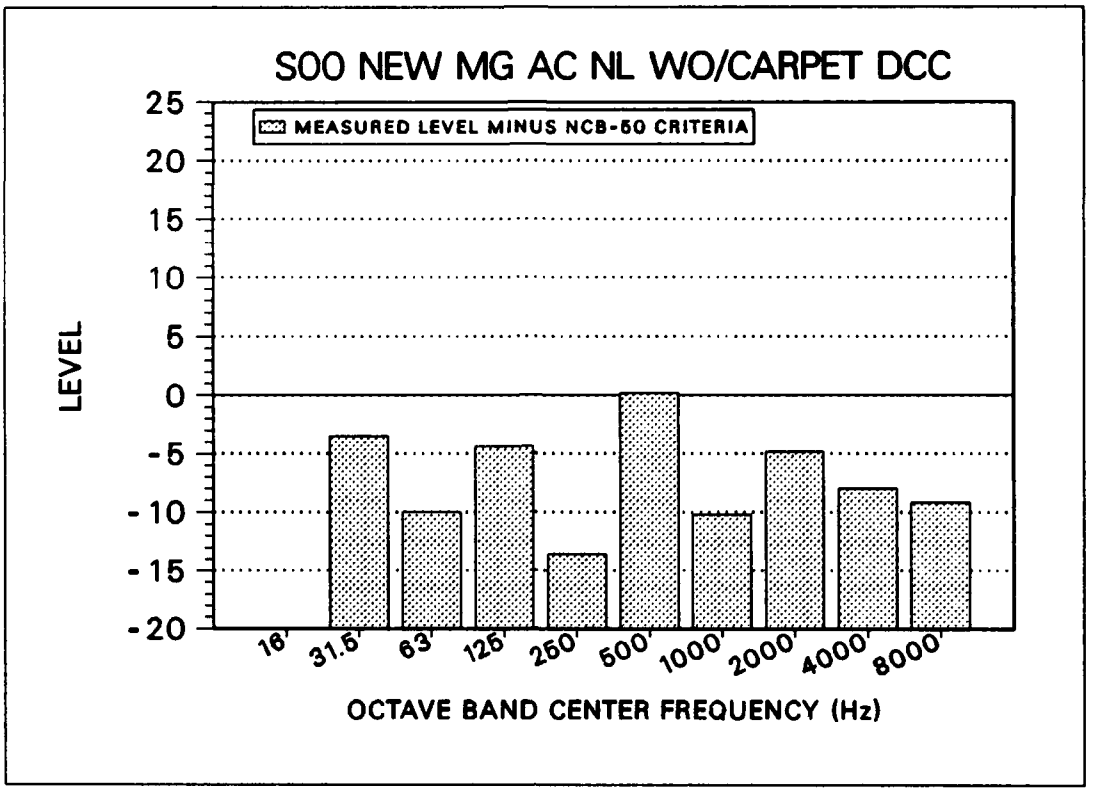
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	70.1	89	−18.9
31.5	73.2	79	−5.8
63	69	69	0
125	64.1	62	2.1
250	63.1	58	5.1
500	63.6	55	8.7
1,000	71.5	52	19.5
2,000	69	49	20
4,000	55.5	46	9.5
8,000	43.3	43	0.3



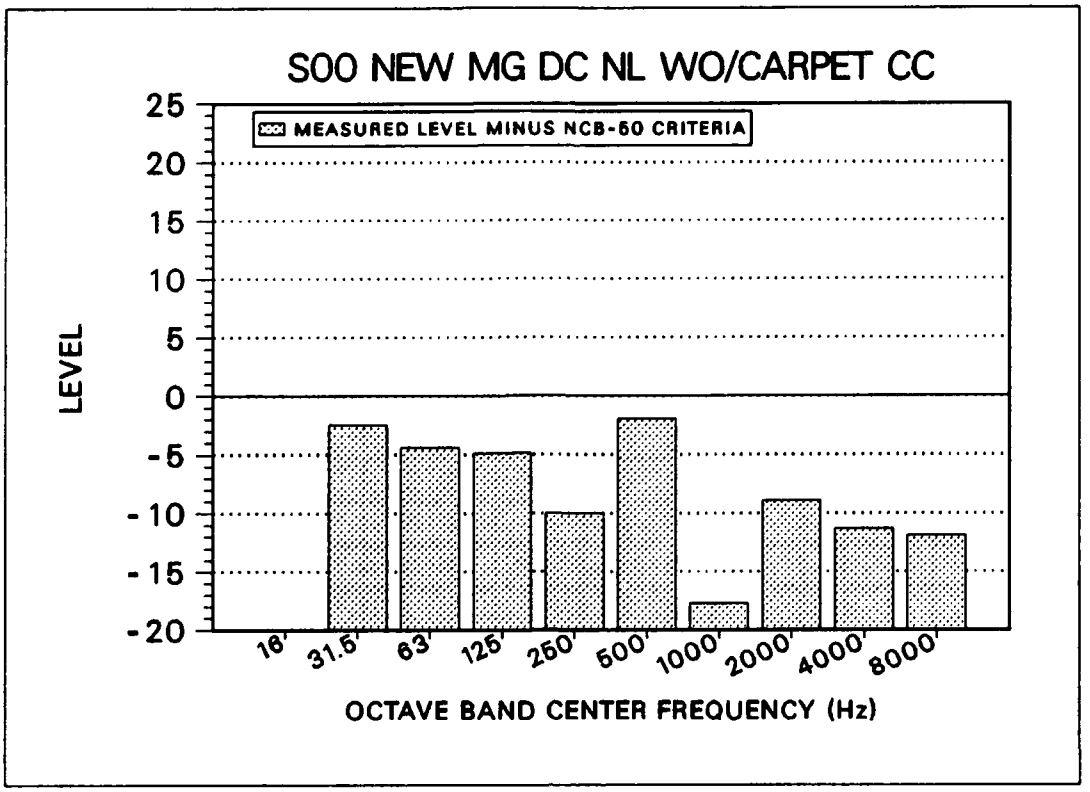
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	65.2	89	-23.8
31.5	74.3	79	-4.7
63	70.5	69	1.6
125	62.8	62	0.8
250	63.2	58	5.2
500	68.3	55	13.3
1,000	73.8	52	21.9
2,000	70.4	49	21.4
4,000	57	46	11
8,000	45.2	43	2.2



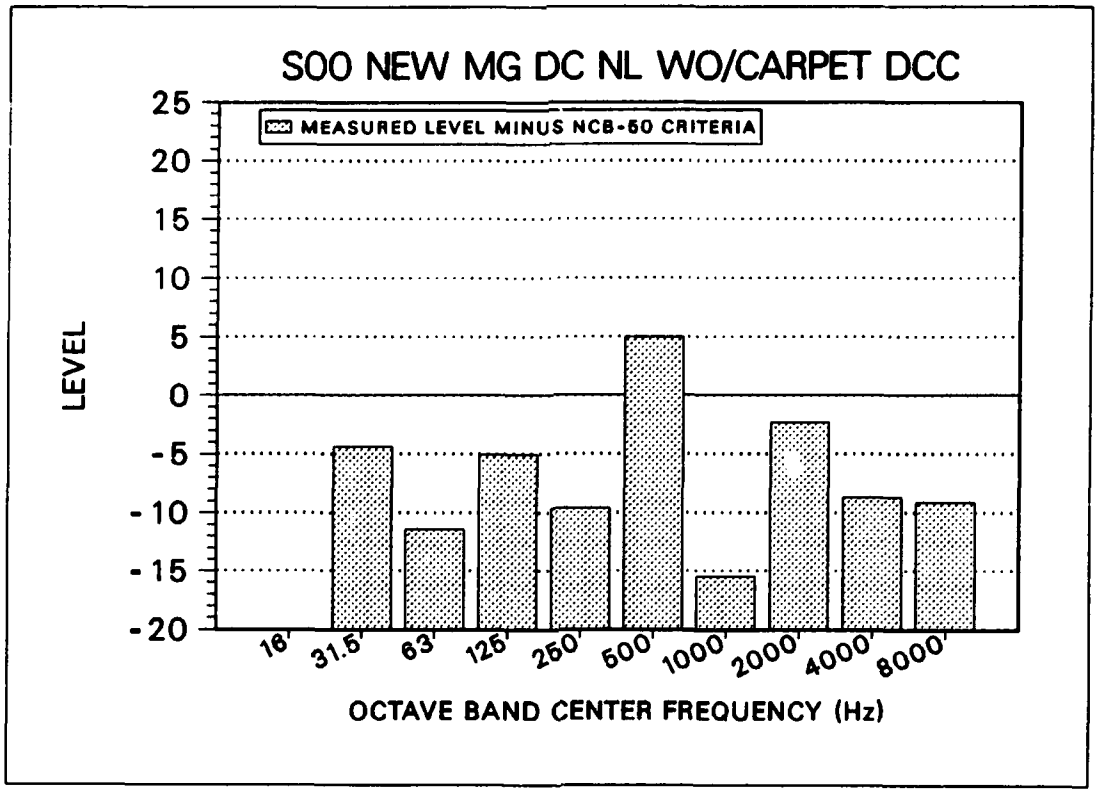
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	37.8	89	−51.2
31.5	75.5	79	−3.4
63	65.7	69	−3.3
125	56	62	−6
250	44.4	58	−13.6
500	56.3	55	1.3
1,000	39.4	52	−12.6
2,000	38.8	49	−10.2
4,000	34.1	46	−11.8
8,000	31.3	43	−11.6



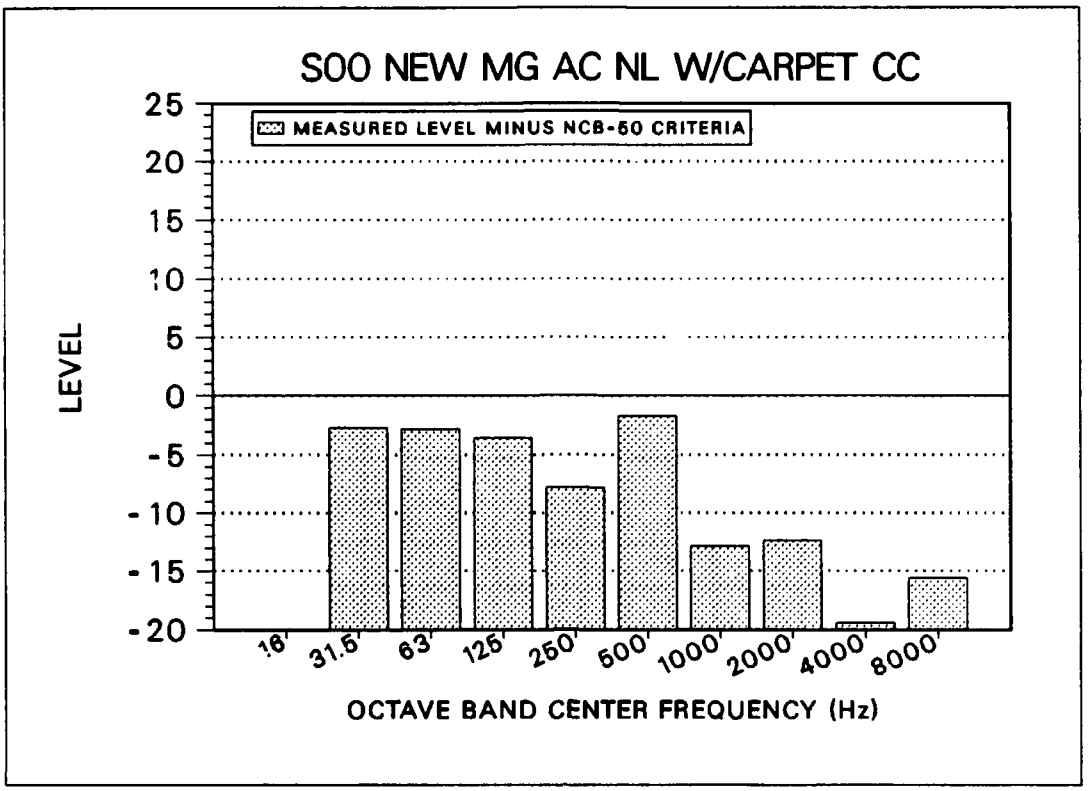
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	35.9	89	−53.1
31.5	75.4	79	−3.5
63	59	69	−10
125	57.6	62	−4.4
250	44.4	58	−13.6
500	55.2	55	0.2
1,000	41.8	52	−10.2
2,000	44.1	49	−4.8
4,000	38	46	−8
8,000	33.8	43	−9.2



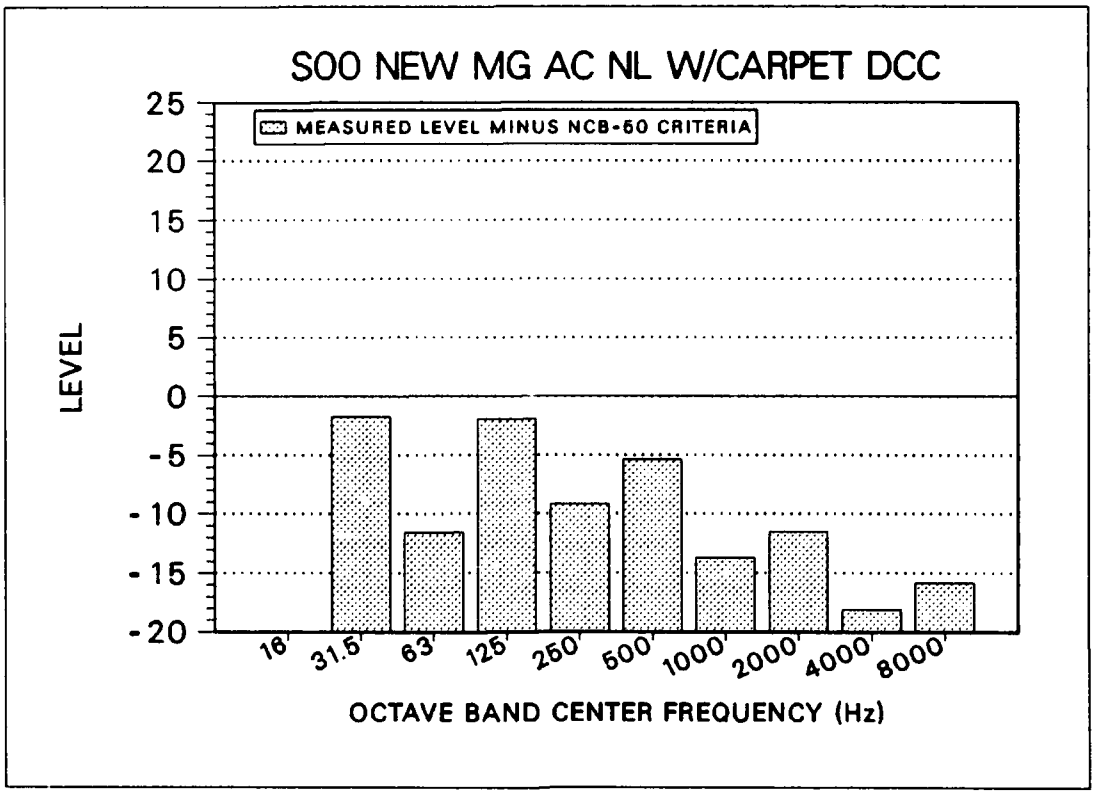
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	36.8	89	−52.1
31.5	76.5	79	−2.5
63	64.5	69	−4.4
125	57.1	62	−4.9
250	48	58	−10
500	53.1	55	−1.9
1,000	34.3	52	−17.7
2,000	40.1	49	−8.9
4,000	34.7	46	−11.3
8,000	31.1	43	−11.9



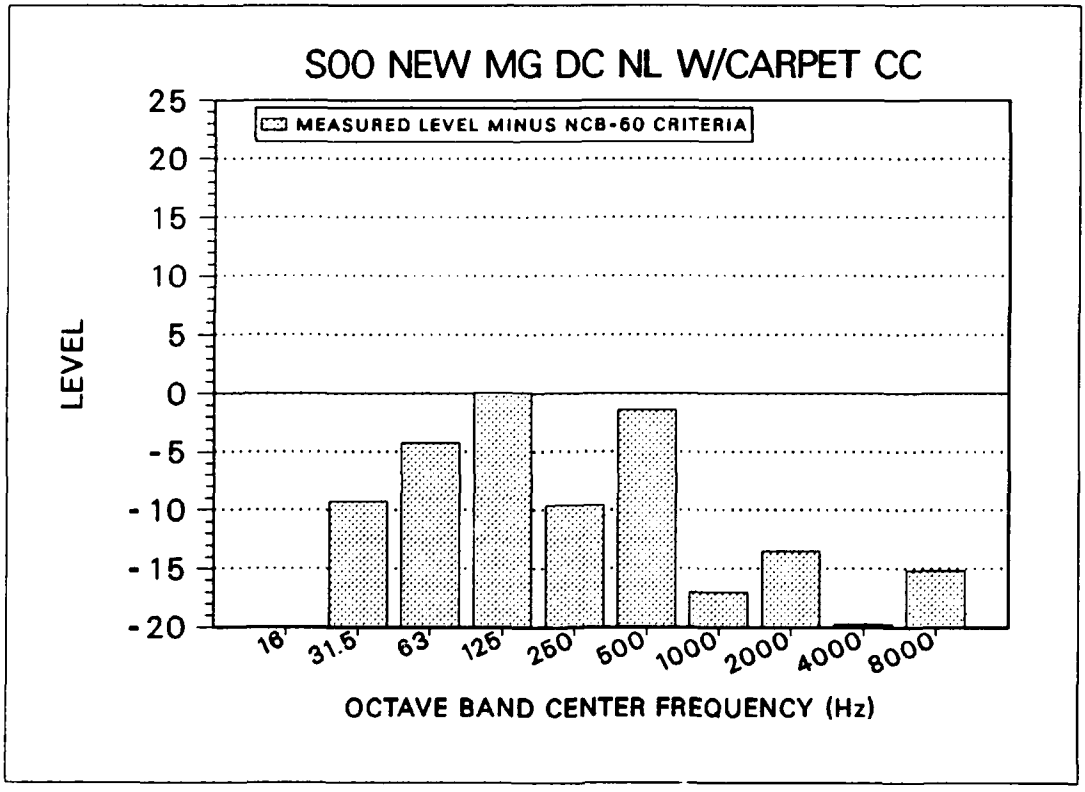
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	34.7	89	−54.3
31.5	74.6	79	−4.4
63	57.6	69	−11.4
125	57	62	−5
250	48.3	58	−9.6
500	60	55	5
1,000	36.4	52	−15.5
2,000	46.7	49	−2.3
4,000	37.2	46	−8.7
8,000	33.9	43	−9.1



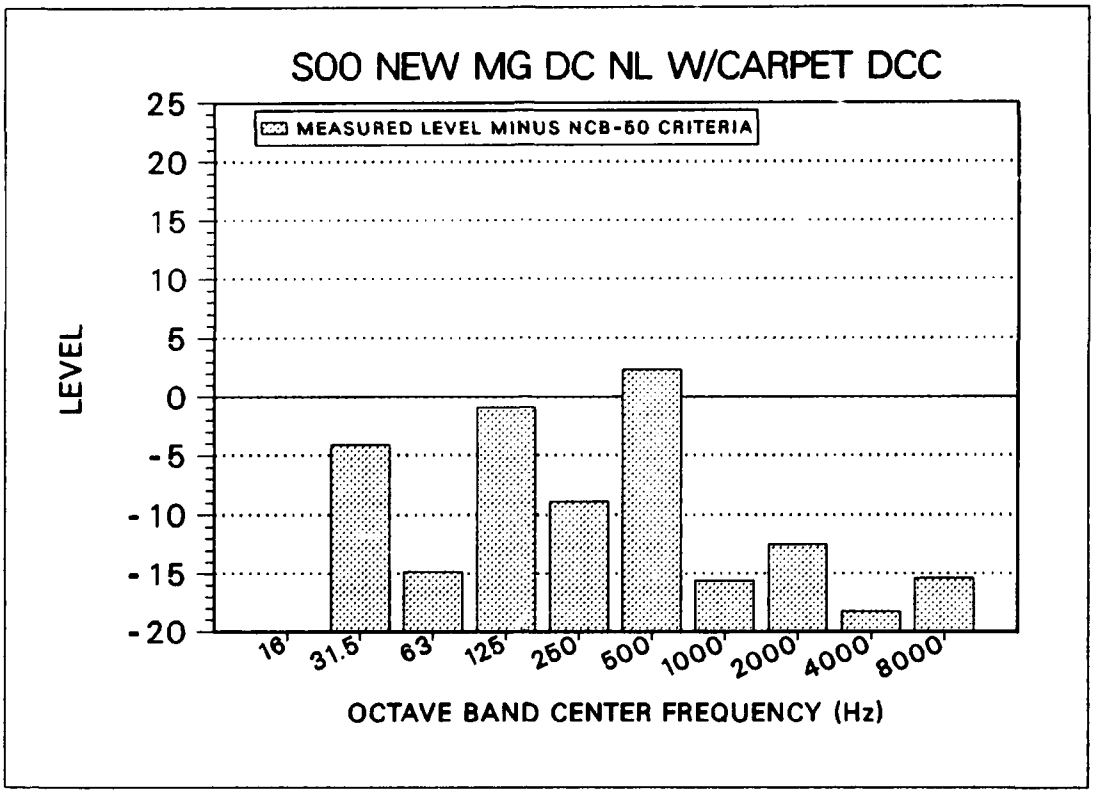
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	40.4	89	−48.6
31.5	76.3	79	−2.7
63	66.2	69	−2.8
125	58.4	62	−3.6
250	50.1	58	−7.8
500	53.3	55	−1.7
1,000	39.1	52	−12.9
2,000	36.6	49	−12.4
4,000	26.6	46	−19.4
8,000	27.4	43	−15.6



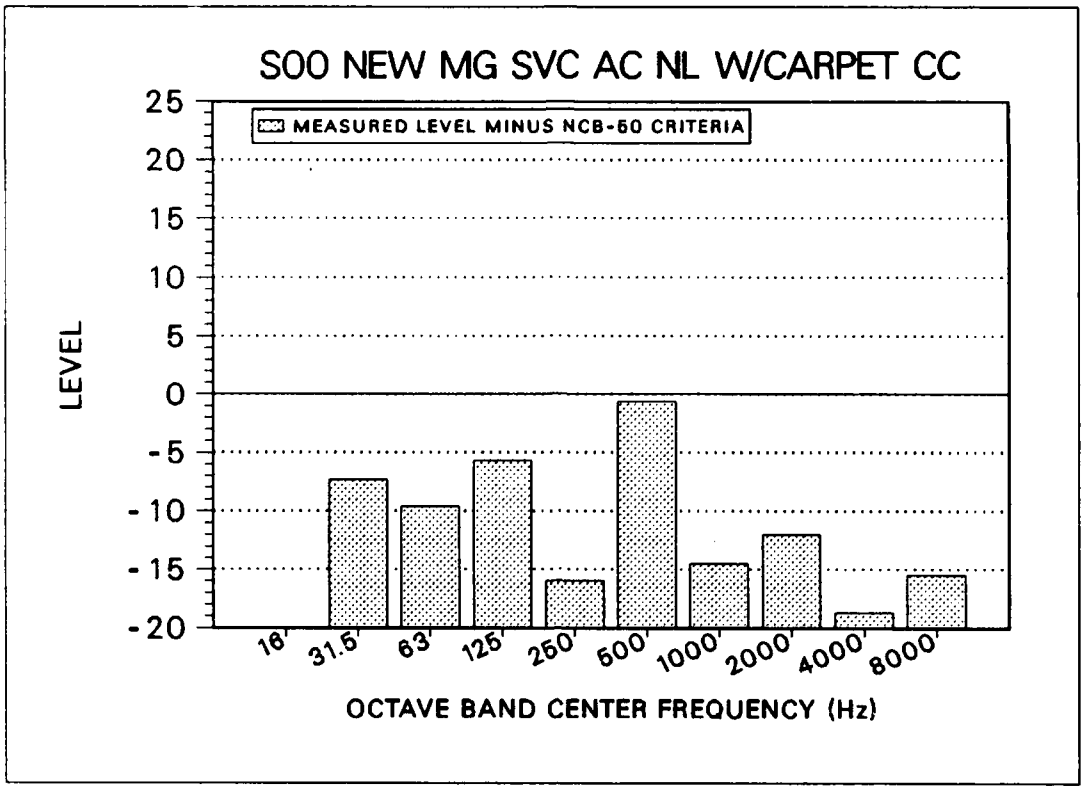
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	37.2	89	−51.7
31.5	77.3	79	−1.7
63	57.4	69	−11.6
125	60.1	62	−1.9
250	48.8	58	−9.2
500	49.6	55	−5.4
1,000	38.3	52	−13.7
2,000	37.5	49	−11.5
4,000	27.9	46	−18.1
8,000	27.2	43	−15.8



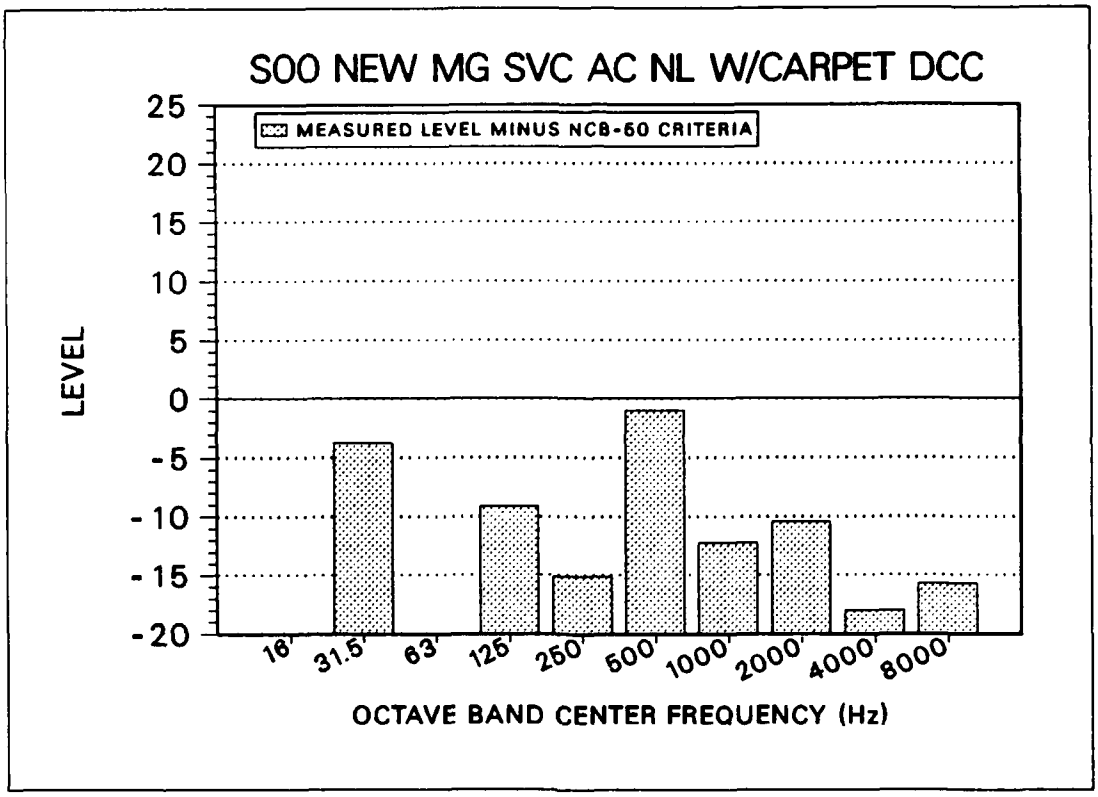
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	40.2	89	−48.8
31.5	69.7	79	−9.3
63	64.8	69	−4.2
125	62.1	62	0.1
250	48.4	58	−9.6
500	53.6	55	−1.4
1,000	35	52	−17
2,000	35.5	49	−13.5
4,000	26.3	46	−19.7
8,000	27.8	43	−15.2



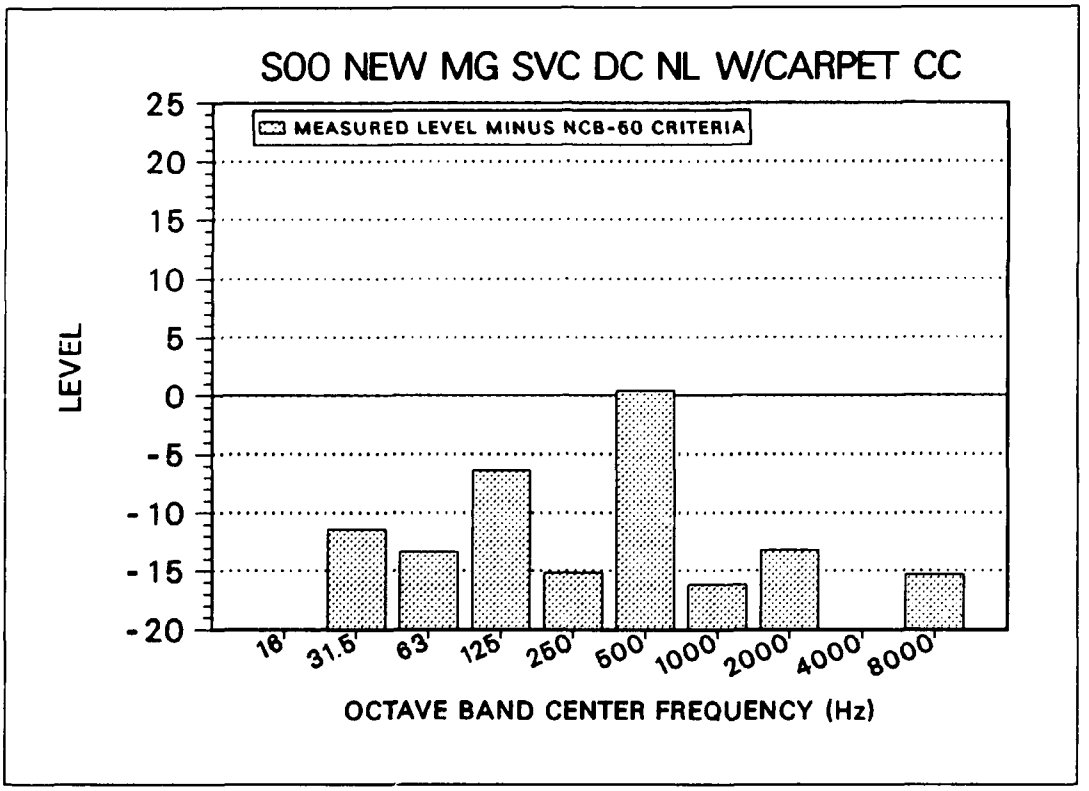
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	37.1	89	−51.9
31.5	74.9	79	−4.1
63	54.2	69	−14.8
125	61.1	62	−0.9
250	49.1	58	−8.9
500	57.3	55	2.3
1,000	36.4	52	−15.6
2,000	36.5	49	−12.5
4,000	27.7	46	−18.3
8,000	27.6	43	−15.4



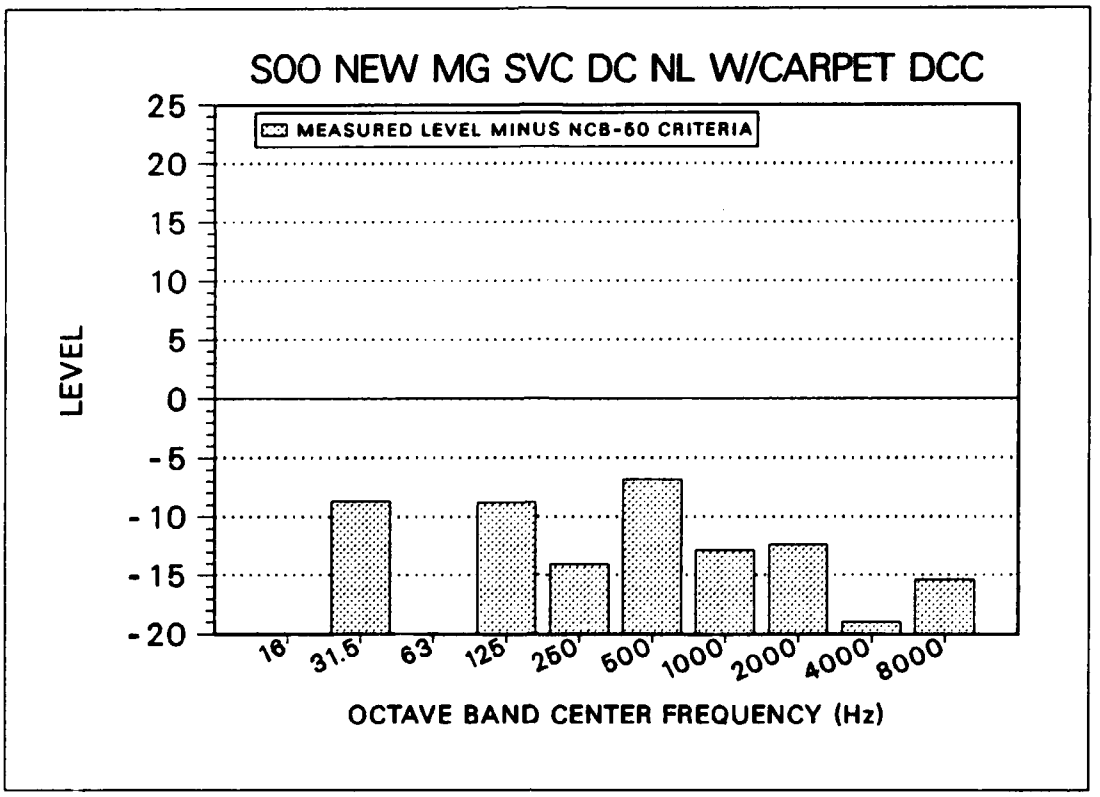
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	41	89	−48
31.5	71.6	79	−7.3
63	59.4	69	−9.6
125	56.3	62	−5.7
250	42	58	−16
500	54.4	55	−0.6
1,000	37.5	52	−14.5
2,000	37	49	−12
4,000	27.3	46	−18.7
8,000	27.4	43	−15.5



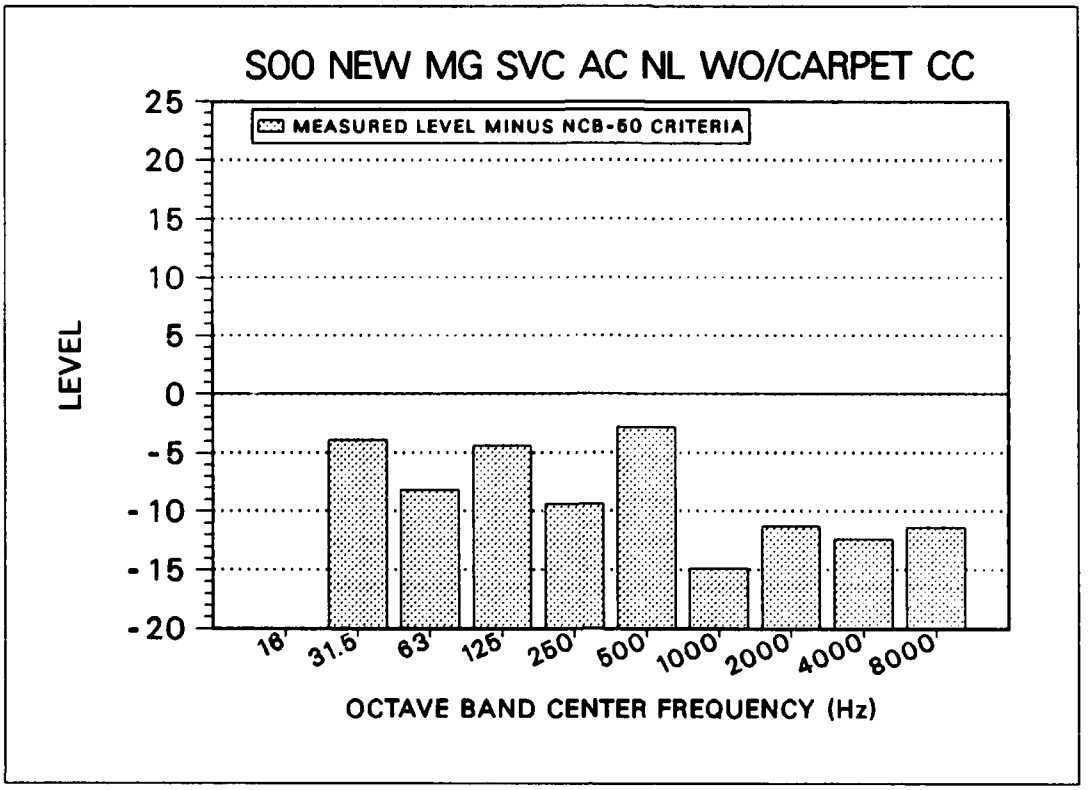
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	37.7	89	−51.3
31.5	75.3	79	−3.7
63	47.9	69	−21.1
125	52.9	62	−9.1
250	42.9	58	−15.1
500	54	55	−1
1,000	39.8	52	−12.2
2,000	38.6	49	−10.4
4,000	28	46	−18
8,000	27.3	43	−15.7



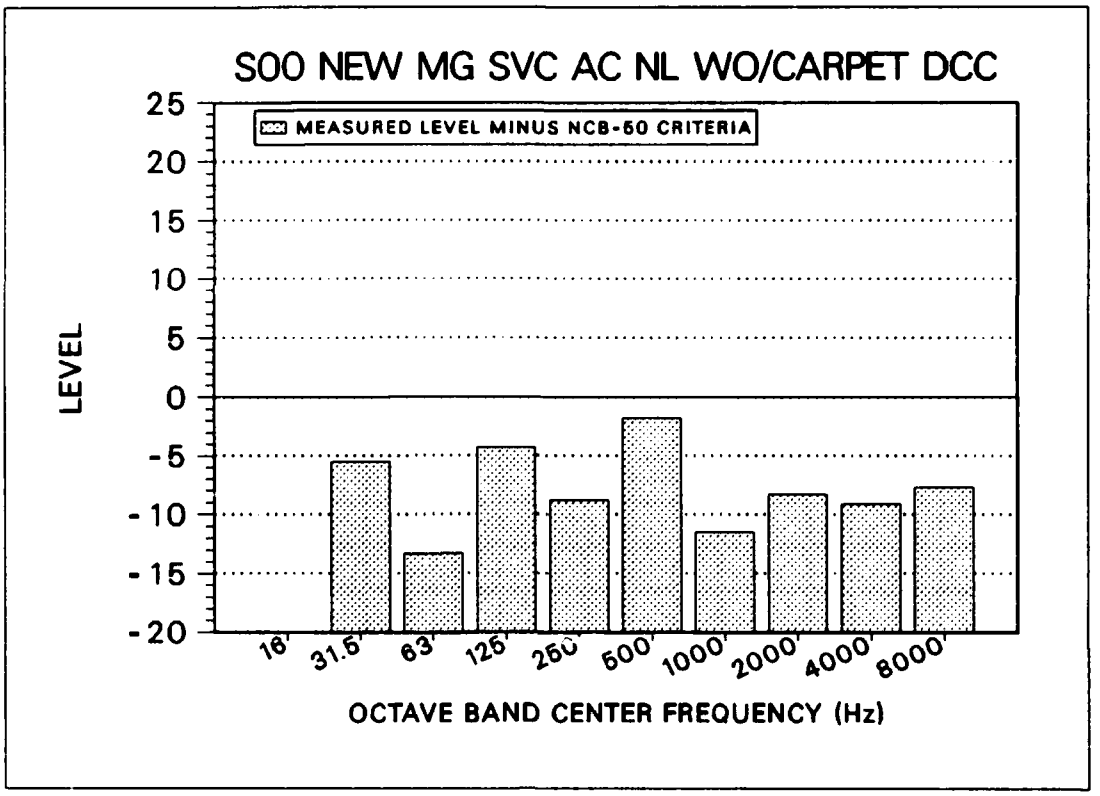
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	42.1	89	−46.9
31.5	67.6	79	−11.4
63	55.6	69	−13.4
125	55.6	62	−6.4
250	42.8	58	−15.2
500	55.4	55	0.4
1,000	35.8	52	−16.2
2,000	35.8	49	−13.2
4,000	25.8	46	−20.2
8,000	27.7	43	−15.3



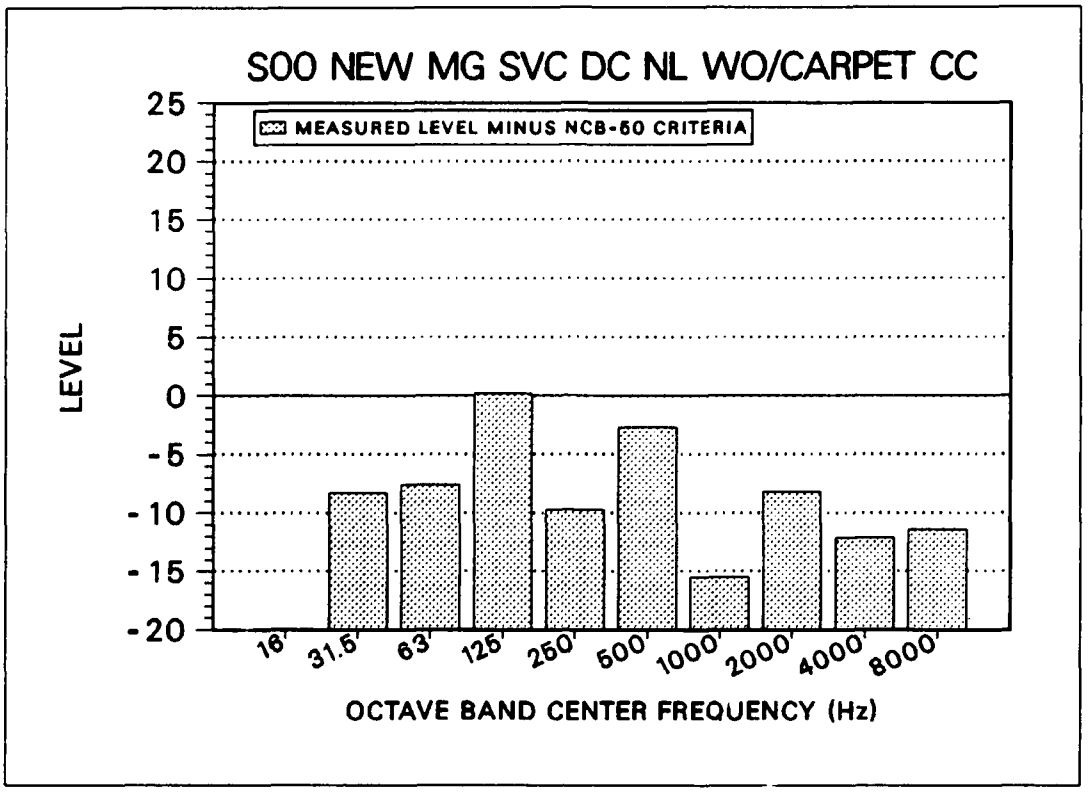
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	38.2	89	−50.8
31.5	70.3	79	−8.7
63	46.5	69	−22.5
125	53.2	62	−8.8
250	43.9	58	−14.1
500	48.2	55	−6.8
1,000	39.1	52	−12.9
2,000	36.6	49	−12.4
4,000	27	46	−19
8,000	27.6	43	−15.4



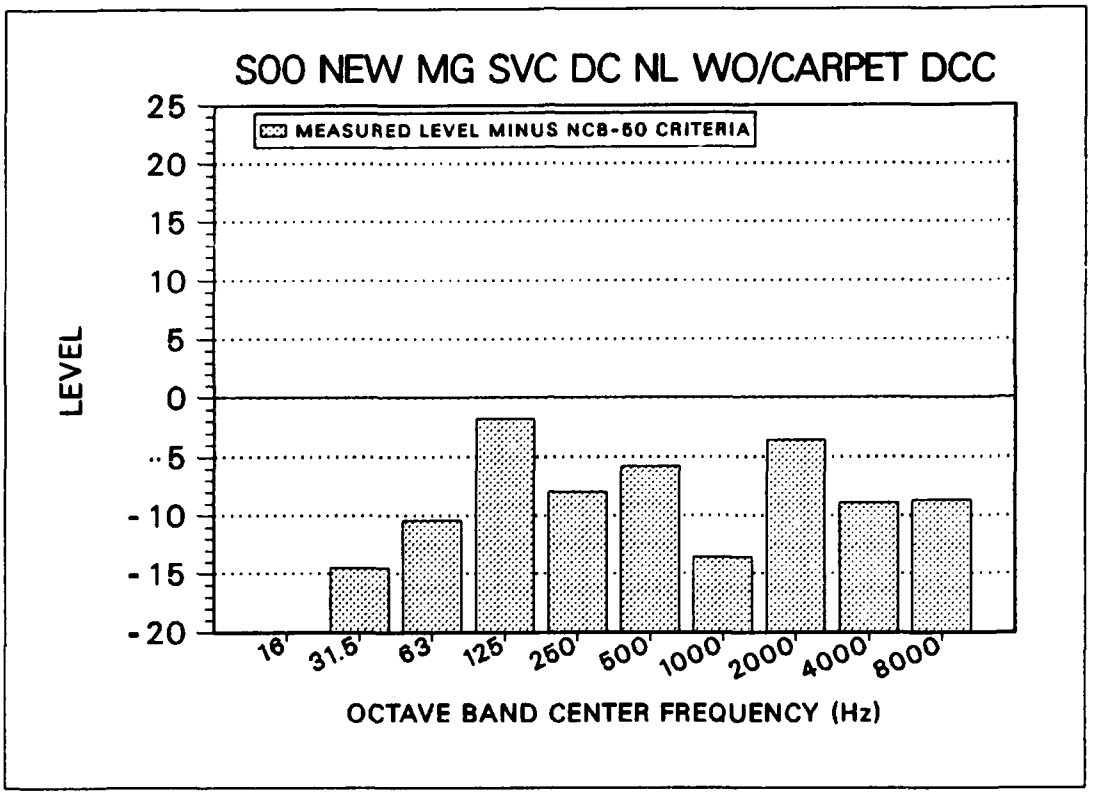
FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	38.2	89	−50.8
31.5	75	79	−3.9
63	60.8	69	−8.2
125	57.6	62	−4.4
250	48.6	58	−9.4
500	52.2	55	−2.8
1,000	37.1	52	−14.9
2,000	37.7	49	−11.3
4,000	33.6	46	−12.4
8,000	31.5	43	−11.4



FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	35.8	89	−53.2
31.5	73.5	79	−5.5
63	55.7	69	−13.3
125	57.6	62	−4.3
250	49.2	58	−8.8
500	53.2	55	−1.8
1,000	40.5	52	−11.5
2,000	40.7	49	−8.3
4,000	36.9	46	−9.1
8,000	35.3	43	−7.7



FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	40.7	89	−48.3
31.5	70.7	79	−8.3
63	61.3	69	−7.6
125	62.2	62	0.2
250	48.3	58	−9.7
500	52.3	55	−2.7
1,000	36.5	52	−15.5
2,000	40.8	49	−8.2
4,000	33.9	46	−12.1
8,000	31.6	43	−11.4

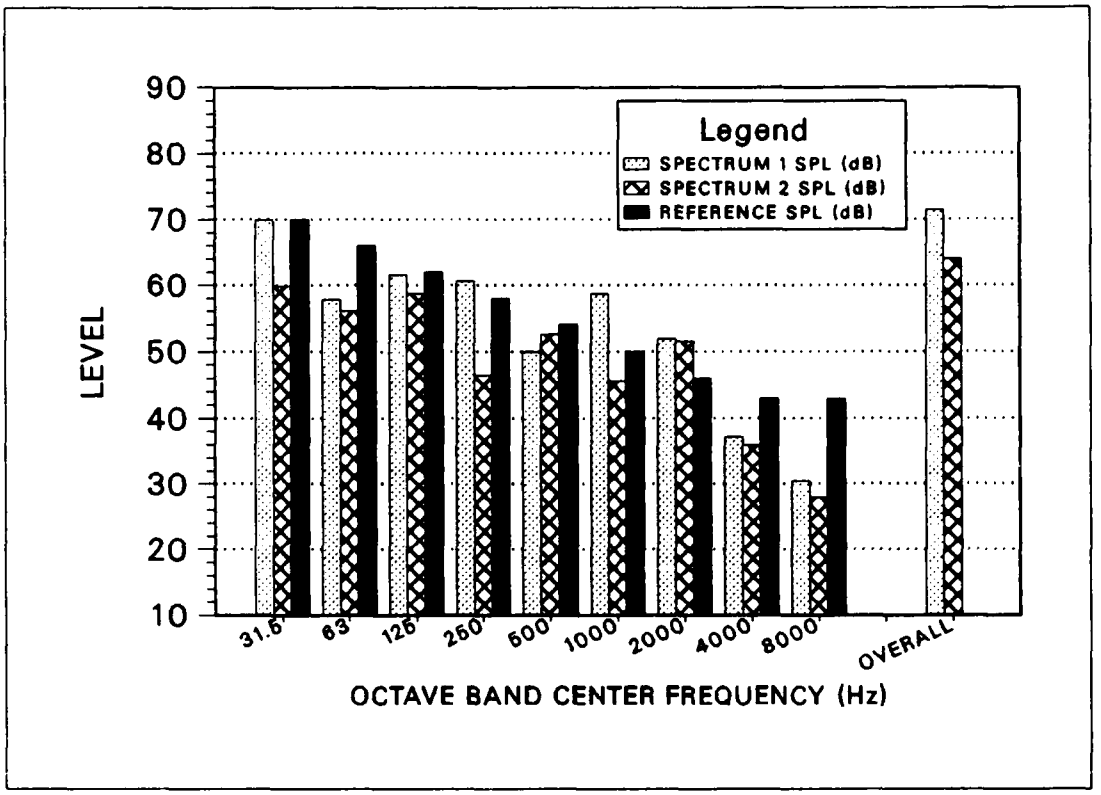


FREQ (Hz)	OCTAVE BAND SPL (dB)	NCB-50 CRITERIA (dB)	MEASURED LEVEL MINUS NCB-50 (dB)
16	36.9	89	−52.1
31.5	64.5	79	−14.5
63	58.5	69	−10.4
125	60.2	62	−1.8
250	49.9	58	−8
500	49.2	55	−5.8
1,000	38.4	52	−13.6
2,000	45.4	49	−3.6
4,000	37.1	46	−8.9
8,000	34.3	43	−8.7

APPENDIX C

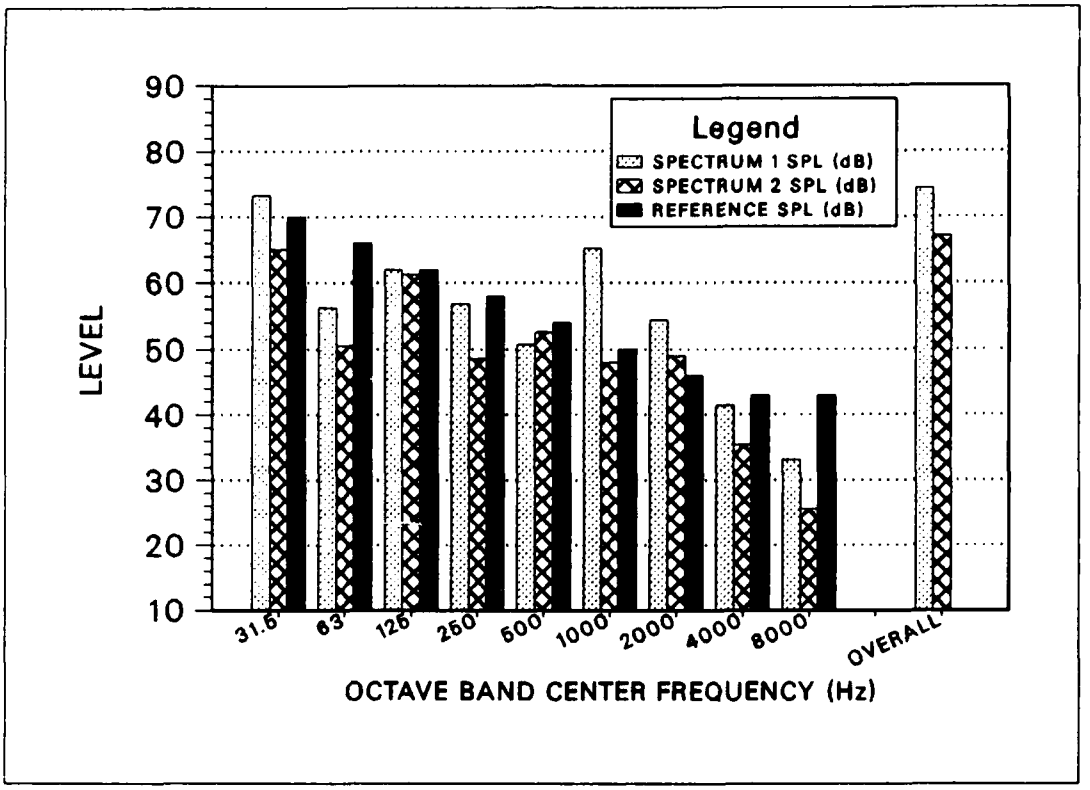
Performance Comparison Measurements

Old MGS vs New MGS



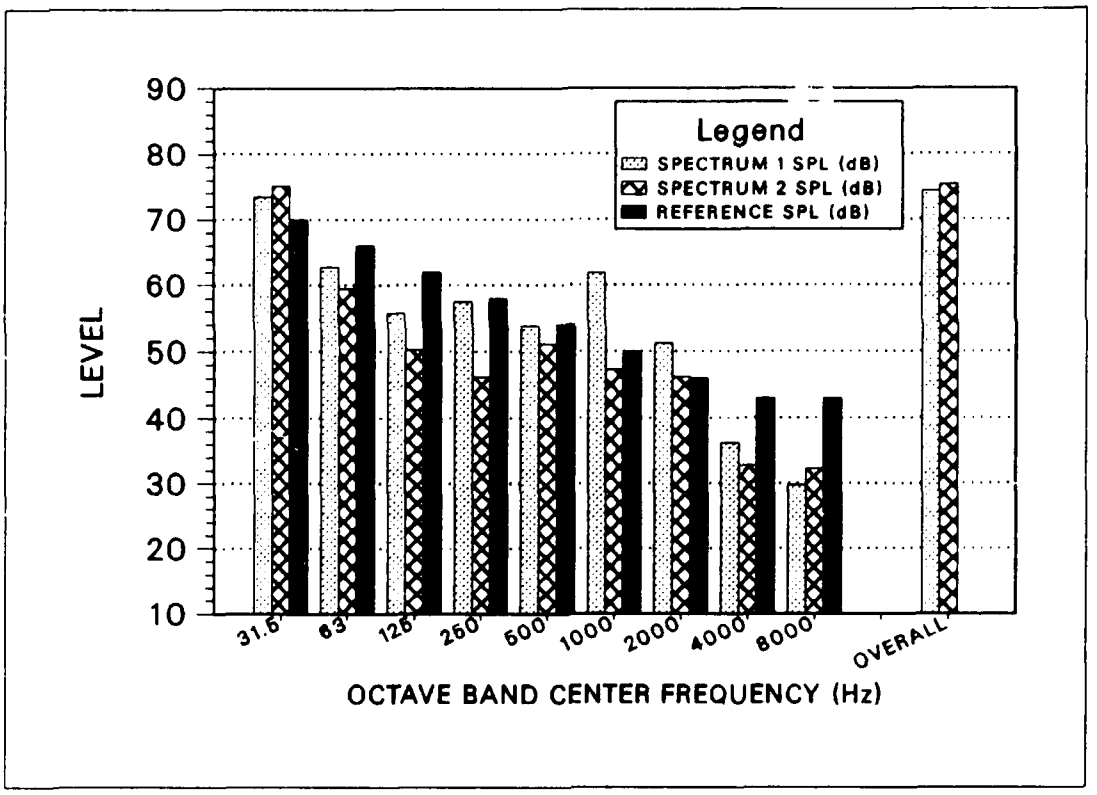
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	69.9	59.8	70
63	57.8	56	66
125	61.5	58.7	62
250	60.6	46.5	58
500	49.9	52.5	54
1,000	58.7	45.6	50
2,000	51.9	51.5	46
4,000	37.2	35.9	43
8,000	30.4	27.9	43
OVERALL	71.4	64	

Alpha 01 acoustic tests at the commander's chair in AC power operation with no load.
Spectrum 1: Measured SPL with old motor generator.
Spectrum 2: Measured SPL with new motor generator.
Reference: PNC-50 Criteria.



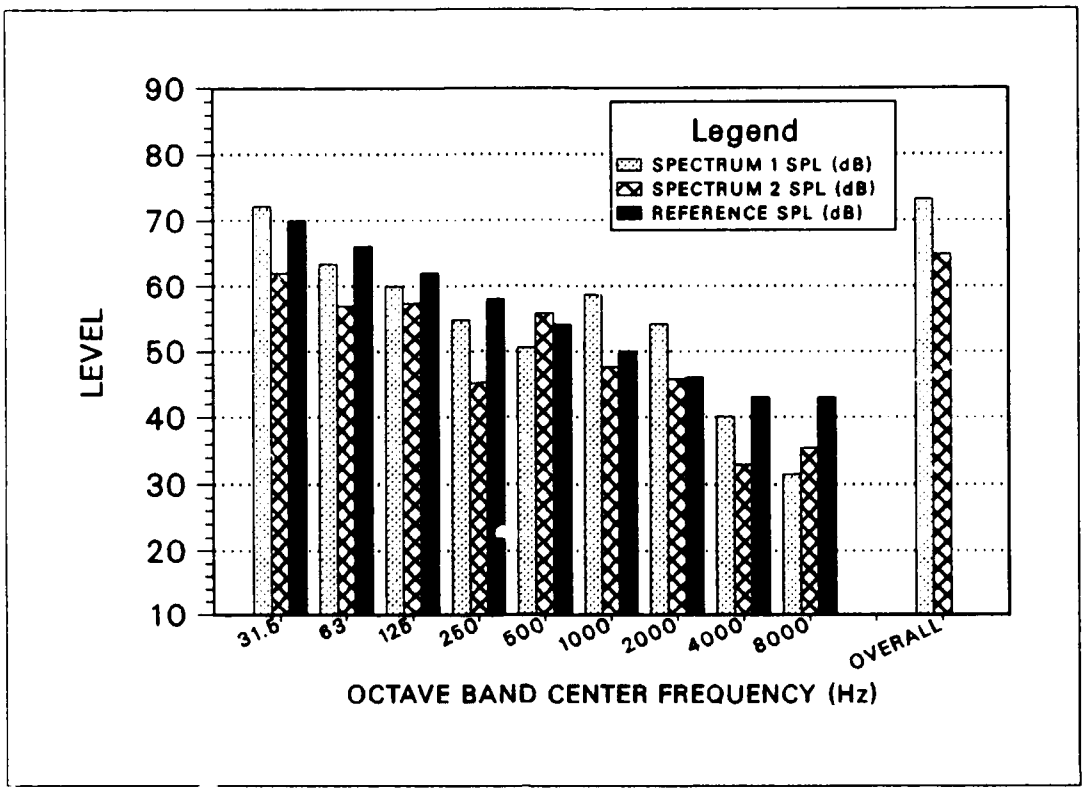
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	73.3	65.1	70
63	56.2	50.5	66
125	62	61.3	62
250	56.8	48.6	58
500	50.7	52.6	54
1,000	65.2	48	50
2,000	54.4	49	46
4,000	41.4	35.4	43
8,000	33.1	25.6	43
OVERALL	74.4	67.1	

Alpha 01 acoustic tests at the deputy commander's chair in AC power operation with no load.
Spectrum 1: Measured SPL with old motor generator.
Spectrum 2: Measured SPL with new motor generator.
Reference: PNC-50 Criteria.



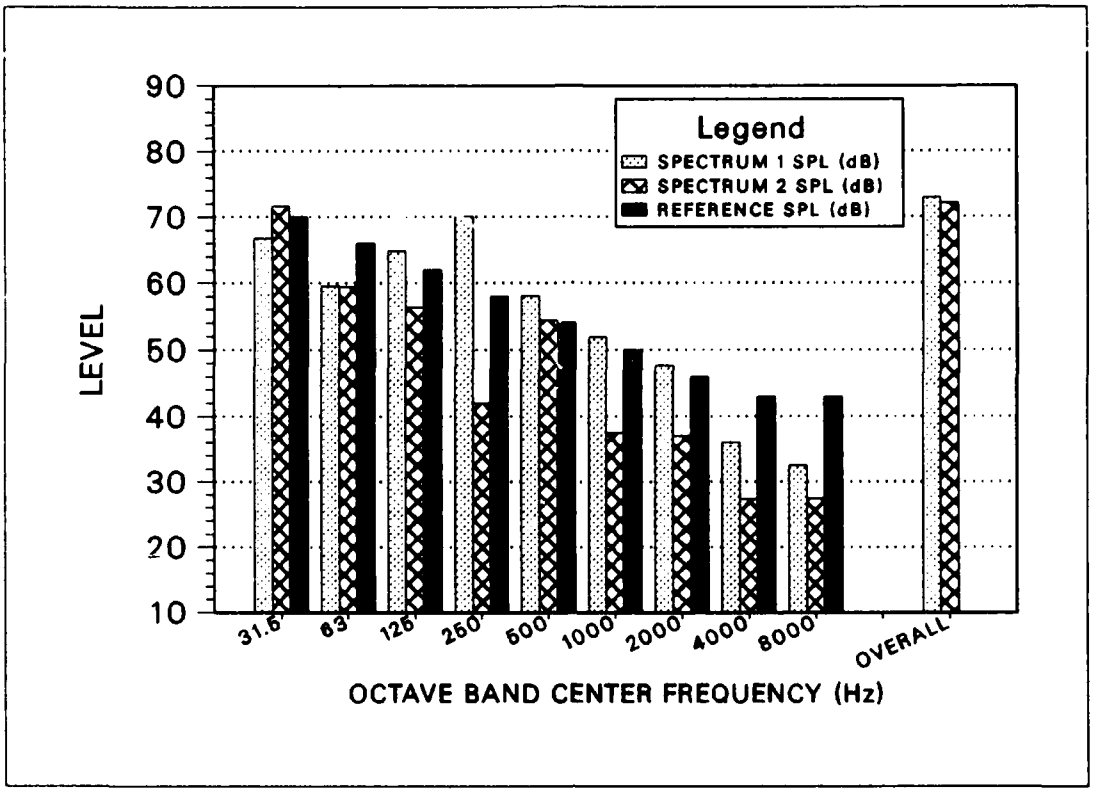
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	73.4	75.1	70
63	62.7	59.4	66
125	55.8	50.2	62
250	57.5	46.2	58
500	53.8	51.1	54
1,000	61.9	47.2	50
2,000	51.2	46.2	46
4,000	36.2	32.7	43
8,000	29.7	32.3	43
OVERALL	74.3	75.3	

Alpha 01 acoustic test at the commander's chair in DC power operation with no load.
Spectrum 1: Measured SPL with old motor generator.
Spectrum 2: Measured SPL with new motor generator.
Reference: PNC-50 Criteria.



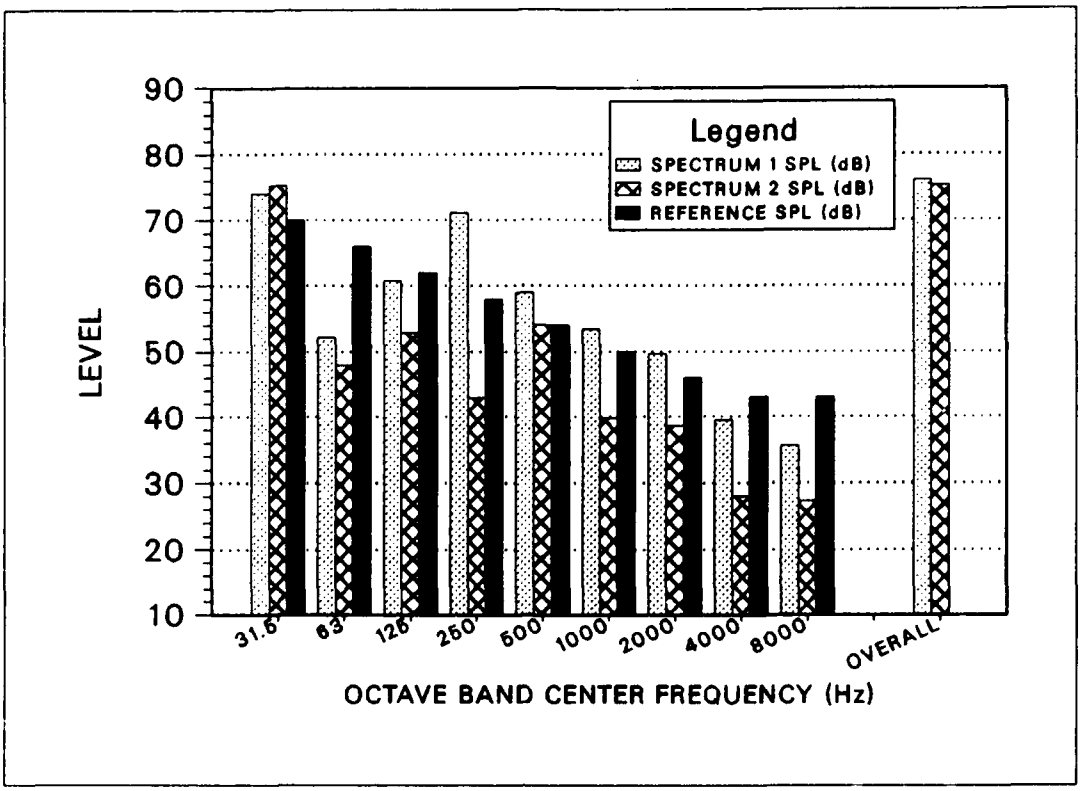
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	72.1	62	70
63	63.4	56.9	66
125	59.9	57.3	62
250	54.8	45.1	58
500	50.6	55.7	54
1,000	58.7	47.5	50
2,000	54.1	45.7	46
4,000	40.1	32.9	43
8,000	31.5	35.4	43
OVERALL	73.2	64.9	

Alpha 01 acoustic tests at the deputy commander's chair in DC power operation with no load.
Spectrum 1: Measured SPL with old motor generator.
Spectrum 2: Measured SPL with new motor generator.
Reference: PNC-50 Criteria.



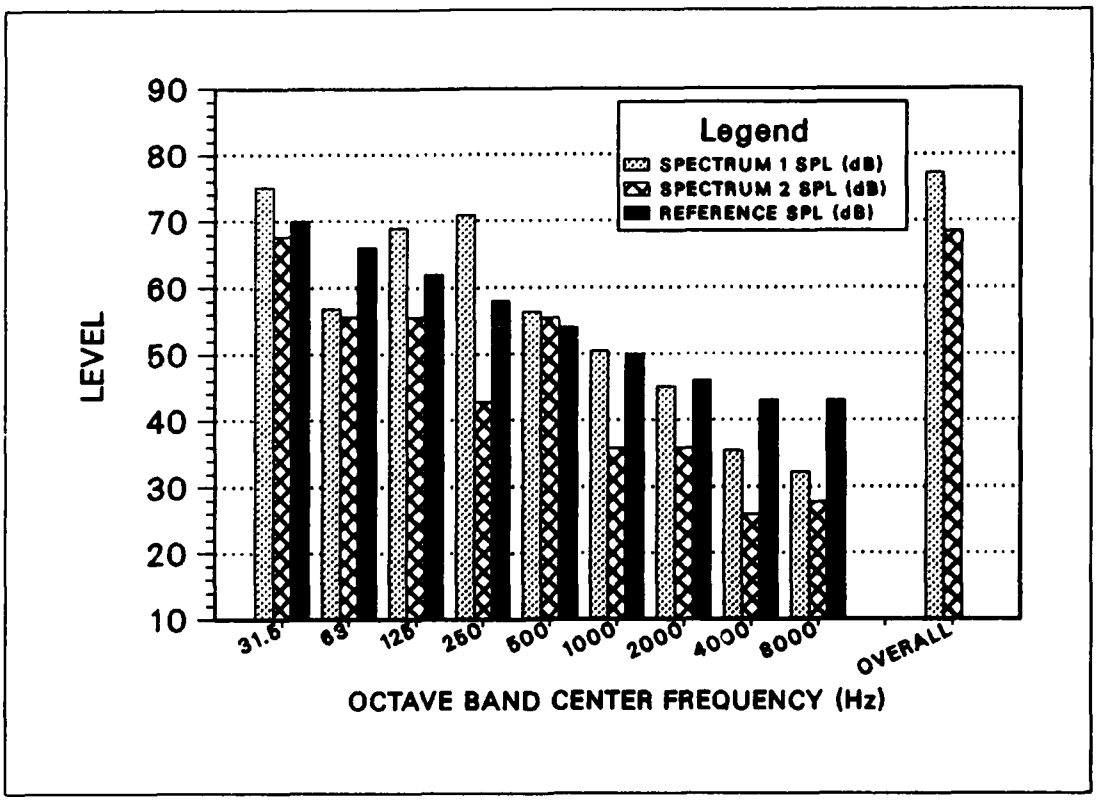
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	66.8	71.6	70
63	59.5	59.4	66
125	64.9	56.3	62
250	70.1	42	58
500	58.1	54.4	54
1,000	51.9	37.5	50
2,000	47.6	37	46
4,000	36	27.3	43
8,000	32.5	27.4	43
OVERALL	73	72.1	

Sierra 00 acoustic tests at the commander's chair in AC power operation with no load.
Spectrum 1: Measured SPL with old motor generator.
Spectrum 2: Measured SPL with new motor generator.
Reference: PNC-50 Criteria.



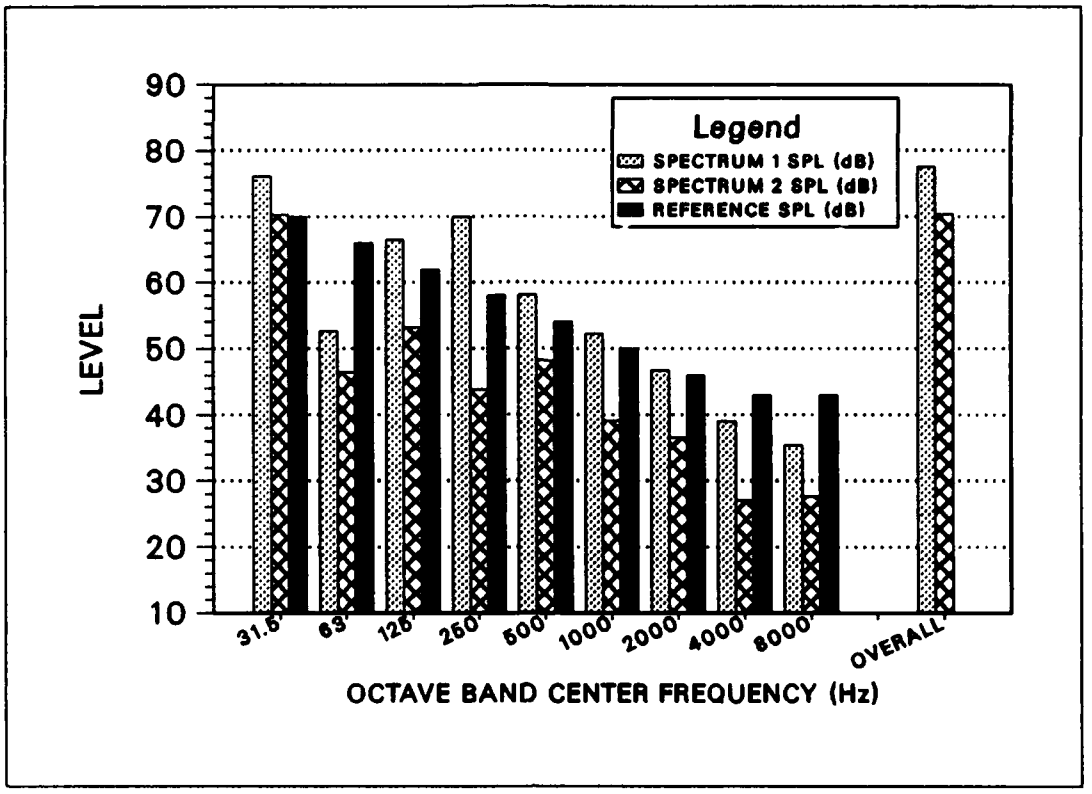
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	74.1	75.3	70
63	52.2	47.9	66
125	60.8	52.9	62
250	71.2	42.9	58
500	59	54	54
1,000	53.5	39.8	50
2,000	49.7	38.6	46
4,000	39.5	28	43
8,000	35.6	27.3	43
OVERALL	76.1	75.3	

Sierra 00 acoustic tests at the deputy commander's chair in AC power operation with no load.
Spectrum 1: Measured SPL with old motor generator.
Spectrum 2: Measured SPL with new motor 'generator.
Reference: PNC-50 Criteria.



FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	75.1	67.6	70
63	56.8	55.6	66
125	68.9	55.6	62
250	71	42.8	58
500	56.4	55.4	54
1,000	50.4	35.8	50
2,000	45	35.8	46
4,000	35.5	25.8	43
8,000	32.3	27.7	43
OVERALL	77.3	68.4	

Sierra 00 acoustic tests at the commander's chair in DC operation with no load.
Spectrum 1: Measured SPL with old motor generator.
Spectrum 2: Measured SPL with new motor generator.
Reference: PNC-50 Criteria.



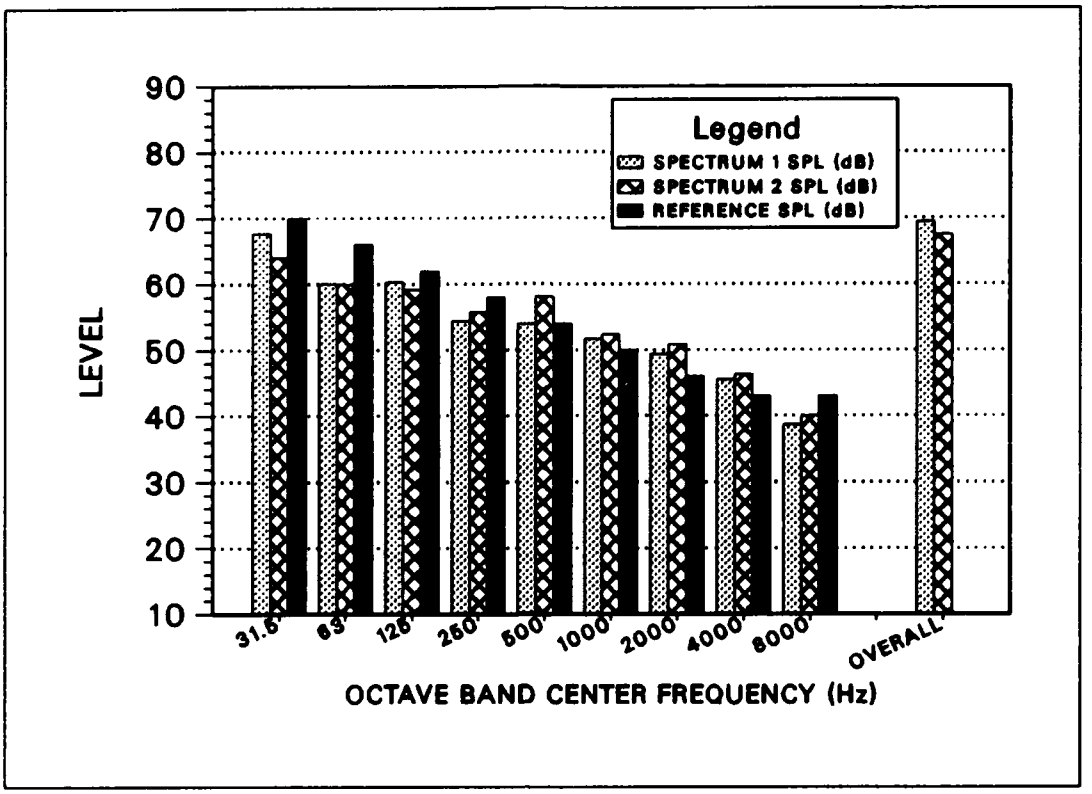
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	76.1	70.3	70
63	52.5	46.5	66
125	66.5	53.2	62
250	70	43.9	58
500	58.1	48.2	54
1,000	52.2	39.1	50
2,000	46.8	36.6	46
4,000	39	27	43
8,000	35.4	27.6	43
OVERALL	77.5	70.4	

Sierra 00 acoustic tests at the deputy commander's chair in DC power operation with no load.
Spectrum 1: Measured SPL with old motor generator.
Spectrum 2: Measured SPL with new motor generator.
Reference: PNC-50 Criteria.

APPENDIX D

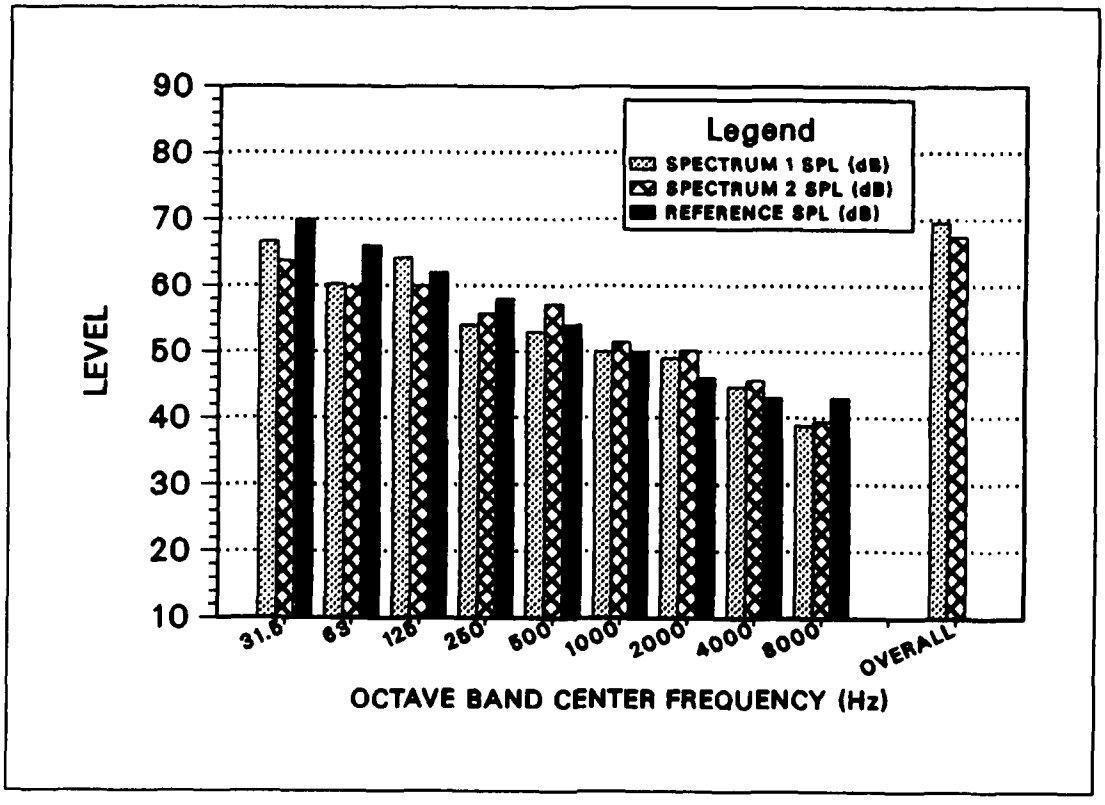
Performance Comparison Measurements

Commander's Chair vs Deputy Commander's Chair



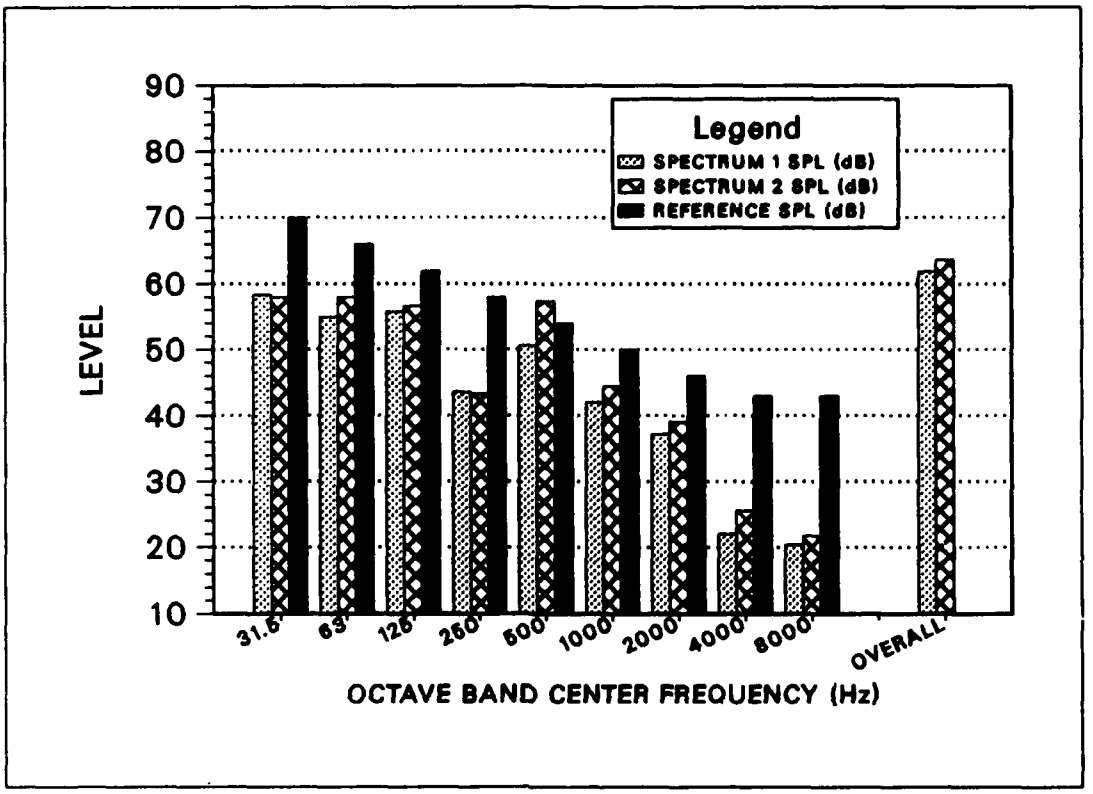
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	67.6	64	70
63	60	59.9	66
125	60.3	59.1	62
250	54.4	55.8	58
500	53.9	58.1	54
1,000	51.7	52.4	50
2,000	49.4	50.8	46
4,000	45.5	46.3	43
8,000	38.6	40	43
OVERALL	69.4	67.5	

Alpha 01 acoustic tests with the new motor generator in AC power operation, ECS on, and acoustic baffles in place.
Spectrum 1: Measured SPL at the commander's chair.
Spectrum 2: Measured SPL at the deputy commander's chair.
Reference: PNC-50 Criteria.



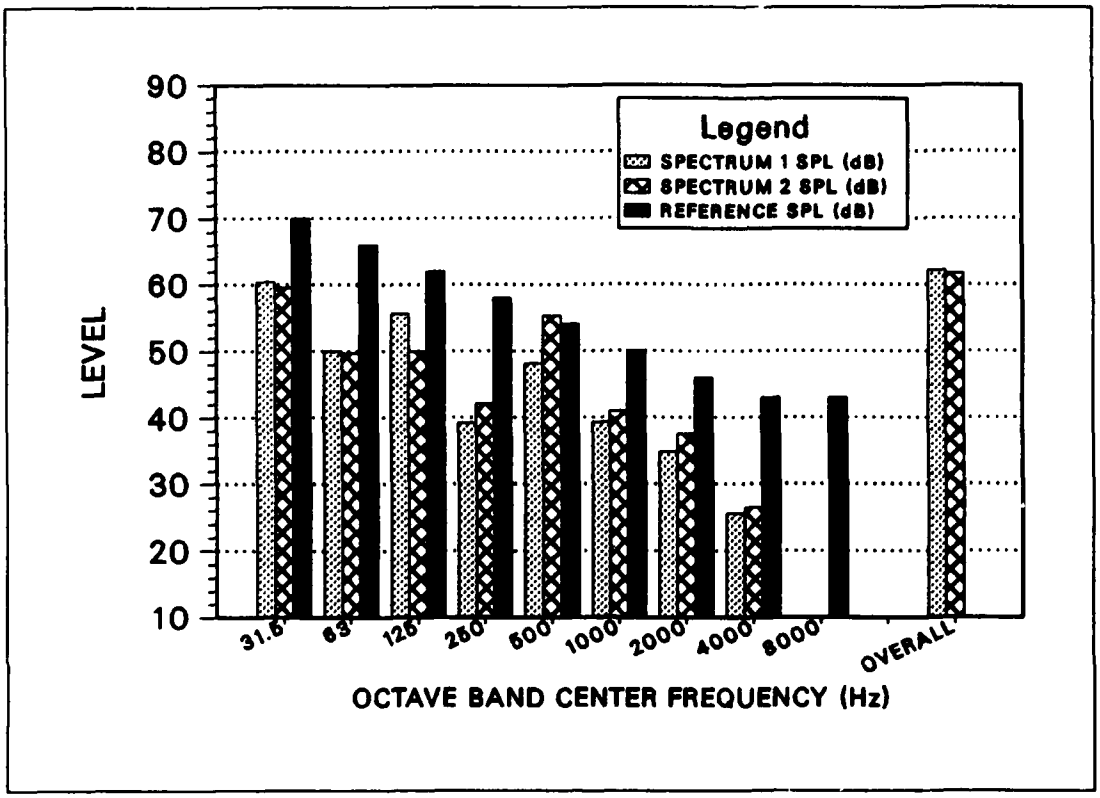
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	66.6	63.7	70
63	60.2	59.7	66
125	64.2	59.9	62
250	54	55.8	58
500	53	57.2	54
1,000	50	51.4	50
2,000	49	50.1	46
4,000	44.6	45.6	43
8,000	38.8	39.4	43
OVERALL	69.5	67.4	

Alpha 01 acoustic tests with the new motor generator in DC power operation, ECS on, and acoustic baffles in place.
Spectrum 1: Measured SPL at the commander's chair.
Spectrum 2: Measured SPL at the deputy commander's chair.
Reference: PNC-50 Criteria.



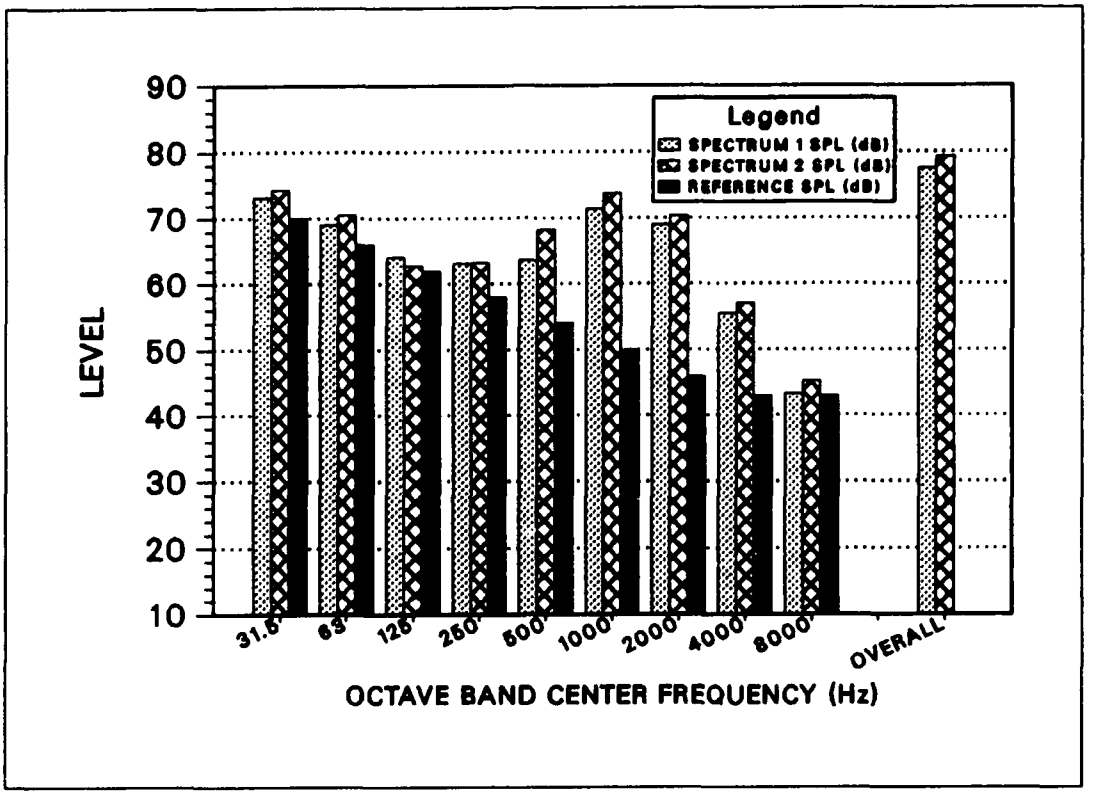
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	58.3	58	70
63	55	58	66
125	55.8	56.6	62
250	43.6	43.3	58
500	50.6	57.4	54
1,000	42	44.5	50
2,000	37.2	39	46
4,000	22	25.6	43
8,000	20.4	21.7	43
OVERALL	61.9	63.6	

Alpha 01 acoustic tests with the new motor generator in AC power operation, ECS off, and acoustic baffles in place.
Spectrum 1: Measured SPL at the commander's chair.
Spectrum 2: Measured SPL at the deputy commander's chair.
Reference: PNC-50 Criteria.



FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	60.4	59.6	70
63	50	49.7	66
125	55.6	50	62
250	39.2	42.1	58
500	48.1	55.3	54
1,000	39.3	41	50
2,000	34.8	37.6	46
4,000	25.5	26.4	43
8,000	N/A	N/A	43
OVERALL	62.2	61.7	

Alpha 01 acoustic tests with the new motor generator in DC power operation, ECS off, and acoustic baffles in place.
Spectrum 1: Measured SPL at the commander's chair.
Spectrum 2: Measured SPL at the deputy commander's chair.
Reference: PNC-50 Criteria.



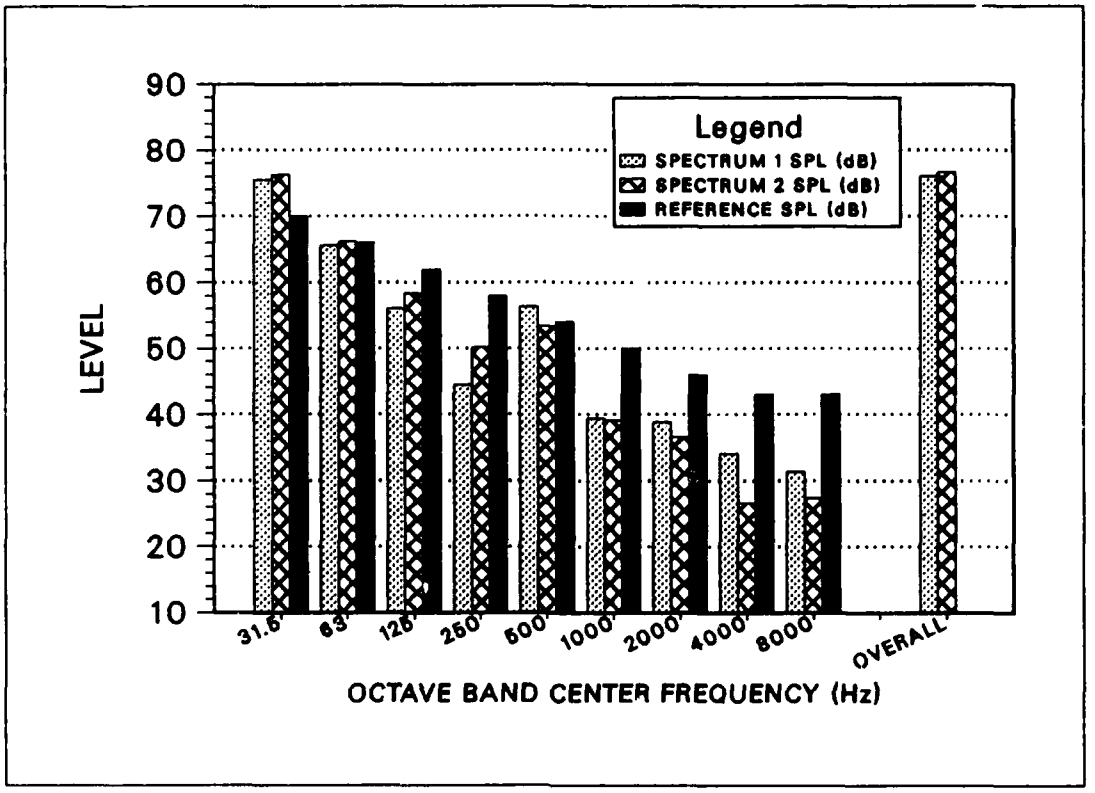
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	73.2	74.3	70
63	69	70.5	66
125	64.1	62.8	62
250	63.1	63.2	58
500	63.6	68.3	54
1,000	71.5	73.8	50
2,000	69	70.4	46
4,000	55.5	57	43
8,000	43.3	45.2	43
OVERALL	77.6	79.3	

Alpha 01 acoustic tests with the new motor generator in AC power operation, EACU on, and acoustic baffles in place.
Spectrum 1: Measured SPL at the commander's chair.
Spectrum 2: Measured SPL at the deputy commander's chair.
Reference: PNC-50 Criteria.

APPENDIX E

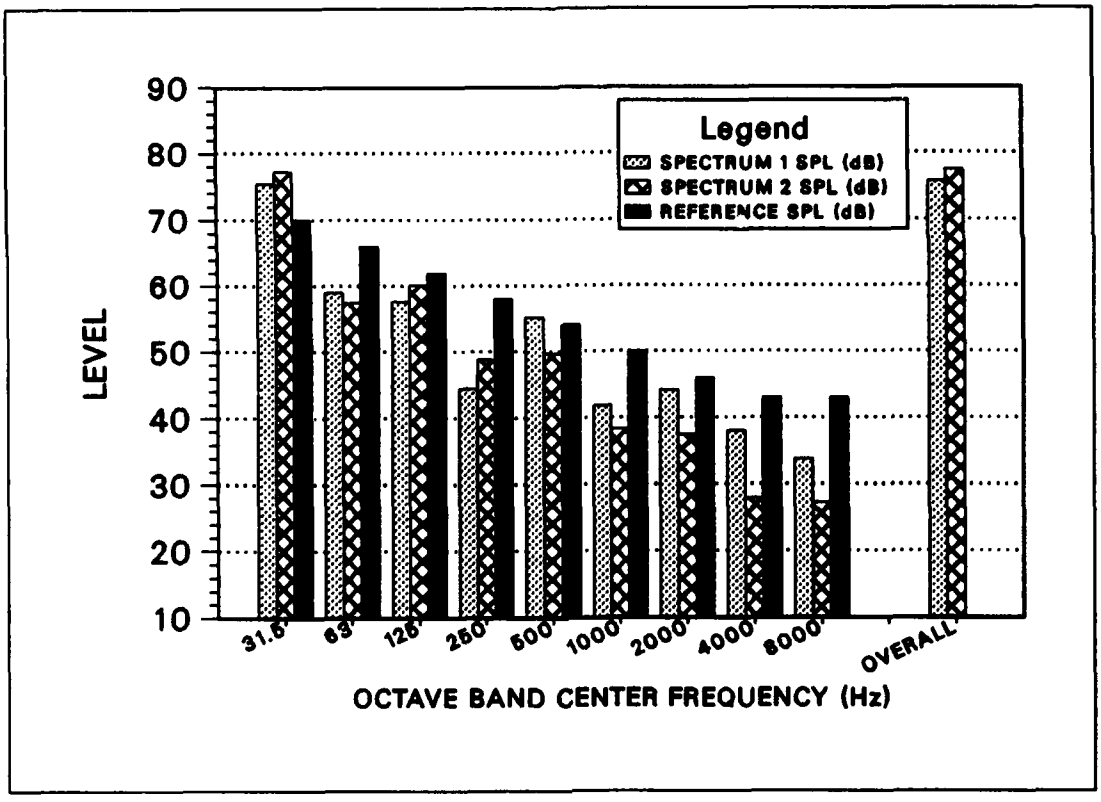
Performance Comparison Measurements

Sierra 00 With and Without Carpet



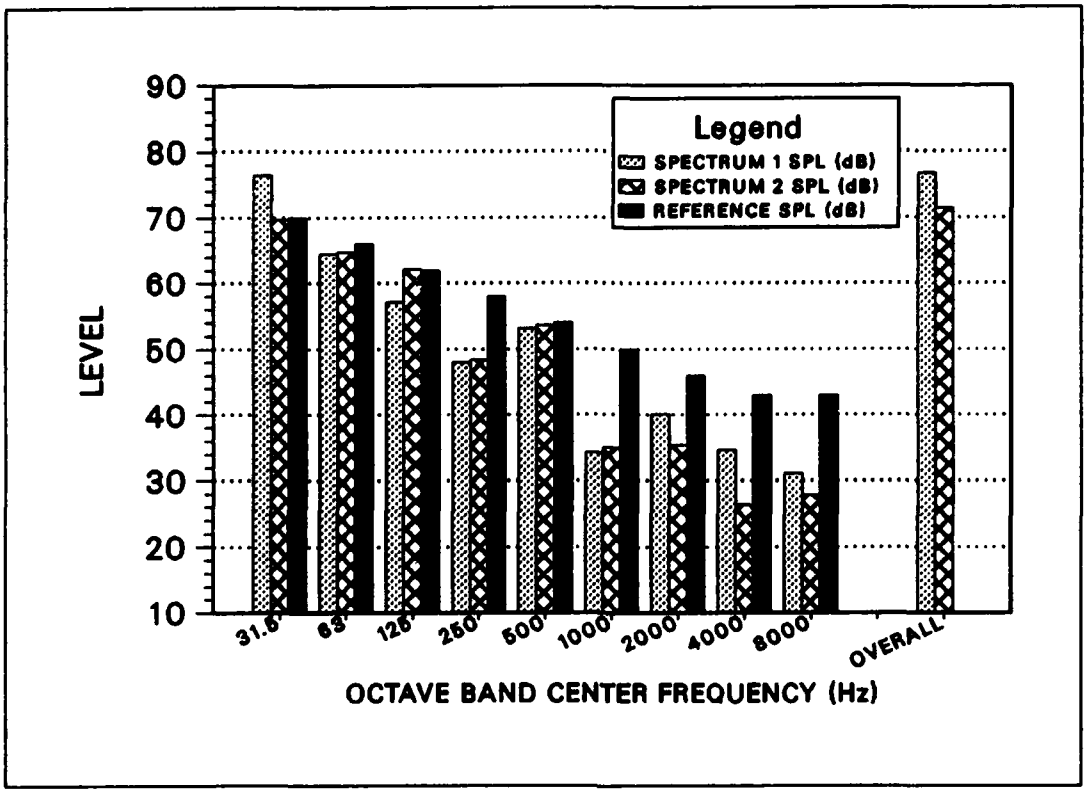
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	75.5	76.3	70
63	65.7	66.2	66
125	56	58.4	62
250	44.4	50.1	58
500	56.3	53.3	54
1,000	39.4	39.1	50
2,000	38.8	36.6	46
4,000	34.1	26.6	43
8,000	31.3	27.4	43
OVERALL	76.1	76.7	

Sierra 00 acoustic tests at the commander's chair with the unserviced new motor generator in AC power operation with no load.
Spectrum 1: Measured SPL without carpet.
Spectrum 2: Measured SPL with carpet.
Reference: PNC-50 Criteria.



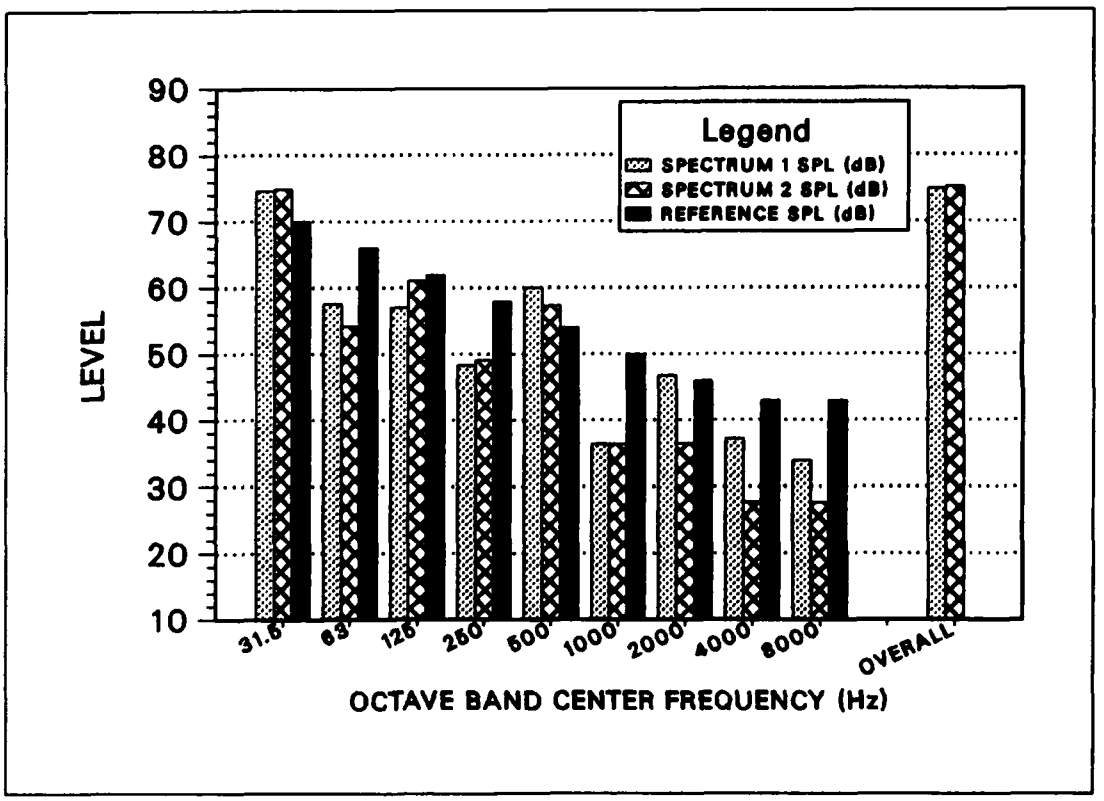
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	75.4	77.3	70
63	59	57.4	66
125	57.6	60.1	62
250	44.4	48.8	58
500	55.2	49.6	54
1,000	41.8	38.3	50
2,000	44.1	37.5	46
4,000	38	27.9	43
8,000	33.8	27.2	43
OVERALL	75.7	77.4	

Sierra 00 acoustic tests at the deputy commander's chair with the unserviced new motor generator in AC power operation with no load.
Spectrum 1: Measured SPL without carpet.
Spectrum 2: Measured SPL with carpet.
Reference: PNC-50 Criteria.



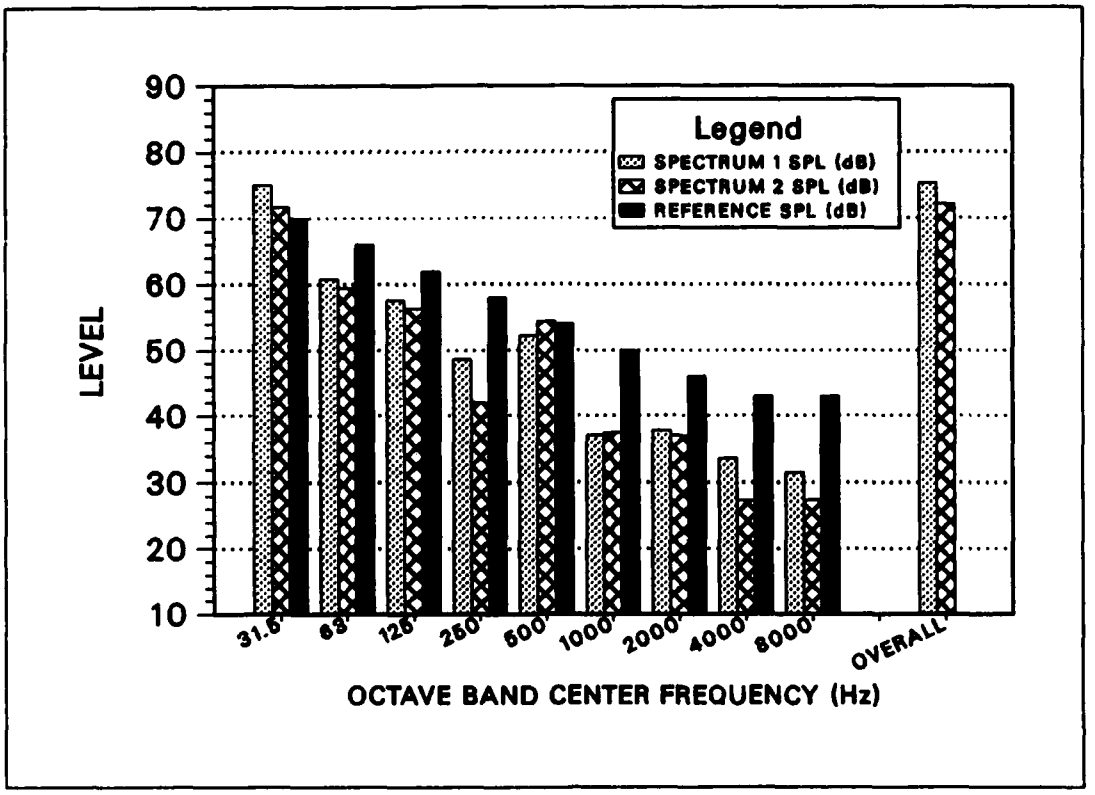
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	76.5	69.7	70
63	64.5	64.8	66
125	57.1	62.1	62
250	48	48.4	58
500	53.1	53.6	54
1,000	34.3	35	50
2,000	40.1	35.5	46
4,000	34.7	26.3	43
8,000	31.1	27.8	43
OVERALL	76.8	71.5	

Sierra 00 acoustic tests at the commander's chair with the unserviced new motor generator in DC power operation with no load.
Spectrum 1: Measured SPL without carpet.
Spectrum 2: Measured SPL with carpet.
Reference: PNC-50 Criteria.



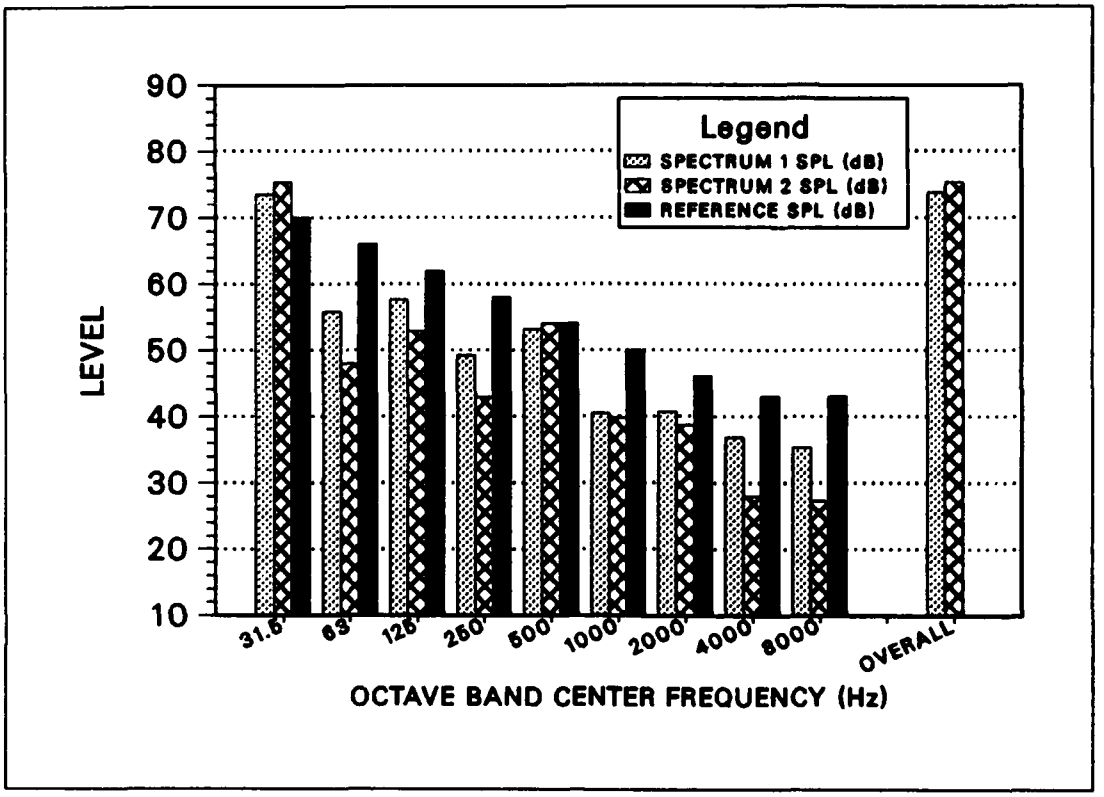
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	74.6	74.9	70
63	57.6	54.2	66
125	57	61.1	62
250	48.3	49.1	58
500	60	57.3	54
1,000	36.4	36.4	50
2,000	46.7	36.5	46
4,000	37.2	27.7	43
8,000	33.9	27.6	43
OVERALL	74.9	75.2	

Sierra 00 acoustic tests at the deputy commander's chair with the unserviced new motor generator in DC power operation with no load.
Spectrum 1: Measured SPL without carpet.
Spectrum 2: Measured SPL with carpet.
Reference: PNC-50 Criteria.



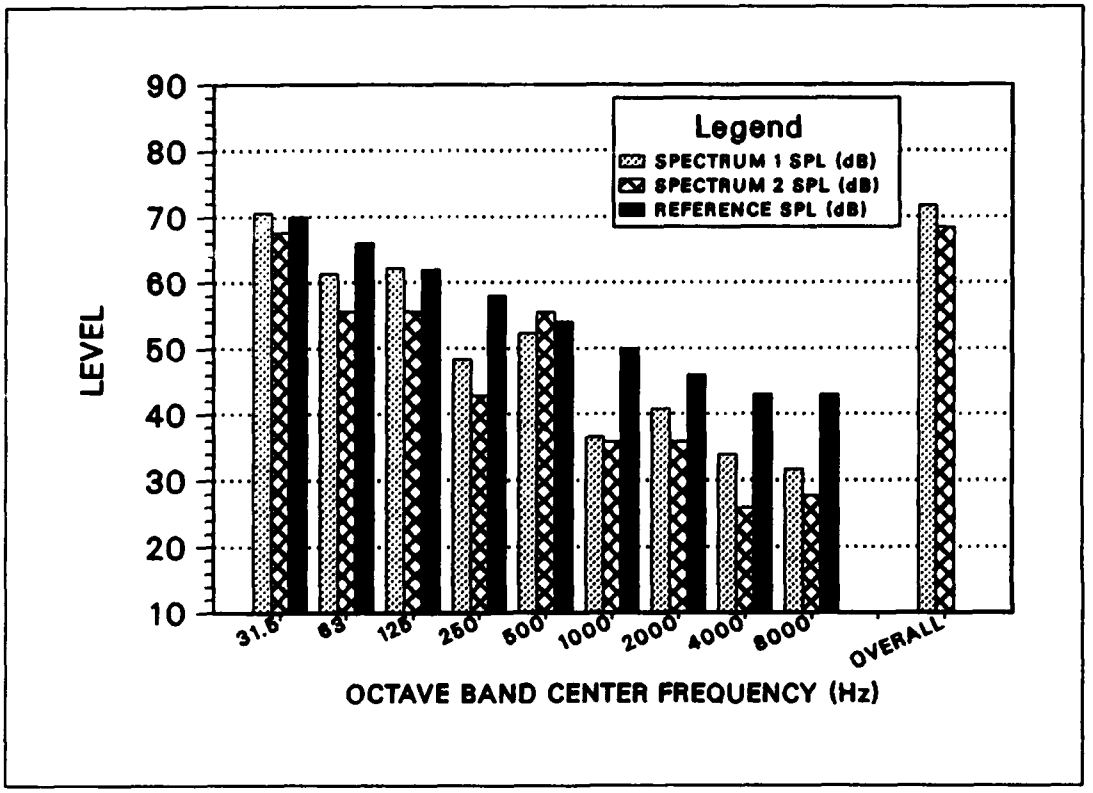
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	75	71.6	70
63	60.8	59.4	66
125	57.6	56.3	62
250	48.6	42	58
500	52.2	54.4	54
1,000	37.1	37.5	50
2,000	37.7	37	46
4,000	33.6	27.3	43
8,000	31.5	27.4	43
OVERALL	75.3	72.1	

Sierra 00 acoustic tests at the commander's chair with the serviced new motor generator in AC power operation with no load.
Spectrum 1: Measured SPL without carpet.
Spectrum 2: Measured SPL with carpet.
Reference: PNC-50 Criteria.



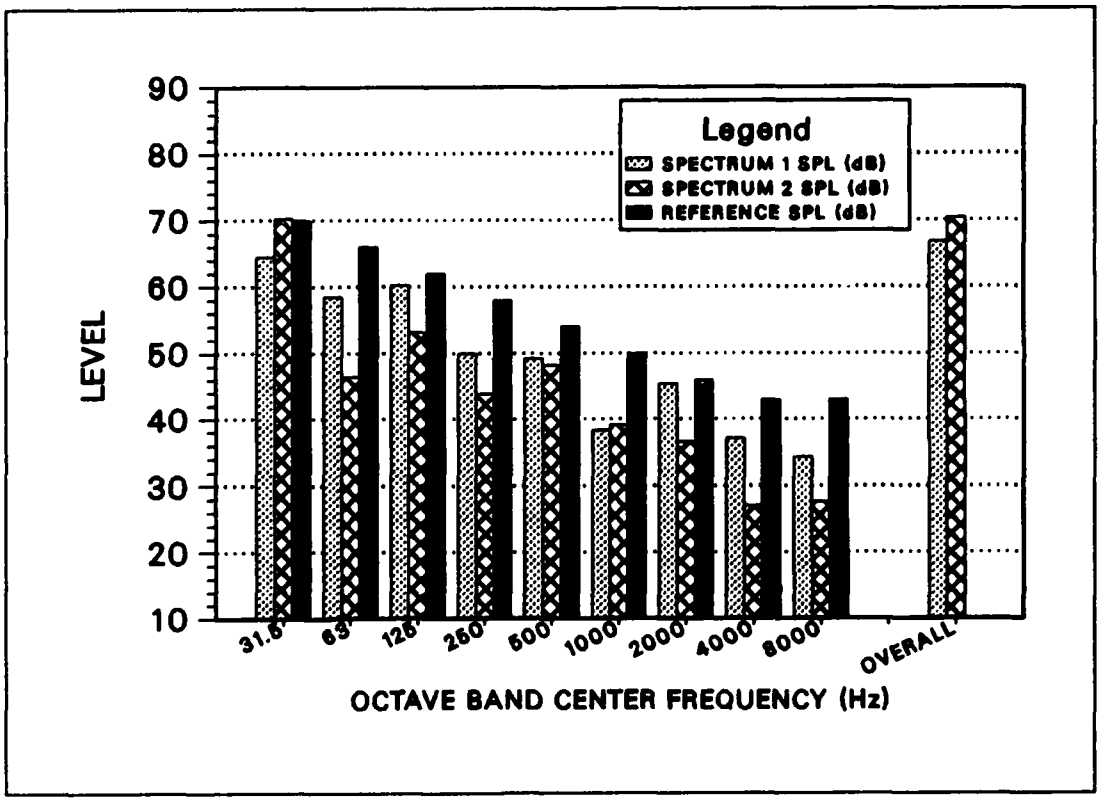
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	73.5	75.3	70
63	55.7	47.9	66
125	57.6	52.9	62
250	49.2	42.9	58
500	53.2	54	54
1,000	40.5	39.8	50
2,000	40.7	38.6	46
4,000	36.9	28	43
8,000	35.3	27.3	43
OVERALL	73.7	75.3	

Sierra 00 acoustic tests at the deputy commander's chair with the serviced new motor generator in AC power operation with no load.
Spectrum 1: Measured SPL without carpet.
Spectrum 2: Measured SPL with carpet.
Reference: PNC-50 Criteria.



FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	70.7	67.6	70
63	61.3	55.6	66
125	62.2	55.6	62
250	48.3	42.8	58
500	52.3	55.4	54
1,000	36.5	35.8	50
2,000	40.8	35.8	46
4,000	33.9	25.8	43
8,000	31.6	27.7	43
OVERALL	71.7	68.4	

Sierra 00 acoustic tests at the commander's chair with the serviced new motor generator in DC power operation with no load.
Spectrum 1: Measured SPL without carpet.
Spectrum 2: Measured SPL with carpet.
Reference: PNC-50 Criteria.



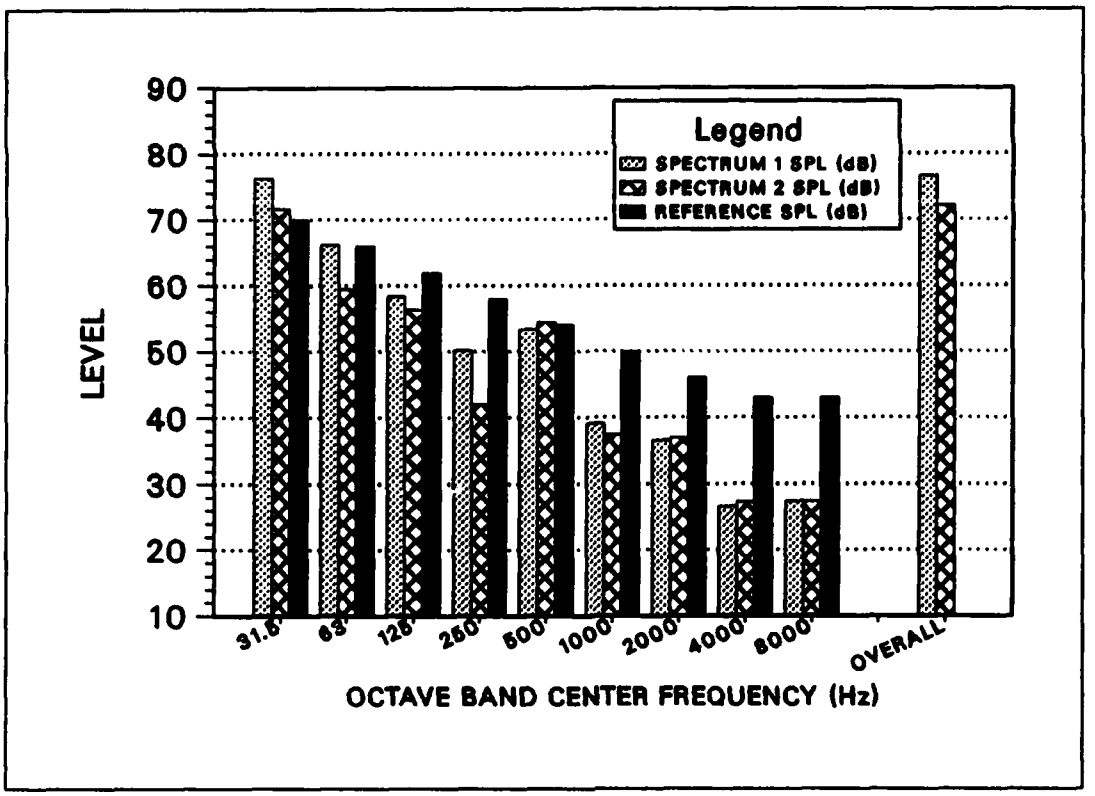
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	64.5	70.3	70
63	58.5	46.5	66
125	60.2	53.2	62
250	49.9	43.9	58
500	49.2	48.2	54
1,000	38.4	39.1	50
2,000	45.4	36.6	46
4,000	37.1	27	43
8,000	34.3	27.6	43
OVERALL	66.8	70.4	

Sierra 00 acoustic tests at the deputy commander's chair with the serviced new motor generator in DC power operation with no load.
Spectrum 1: Measured SPL without carpet.
Spectrum 2: Measured SPL with carpet.
Reference: PNC-50 Criteria.

APPENDIX F

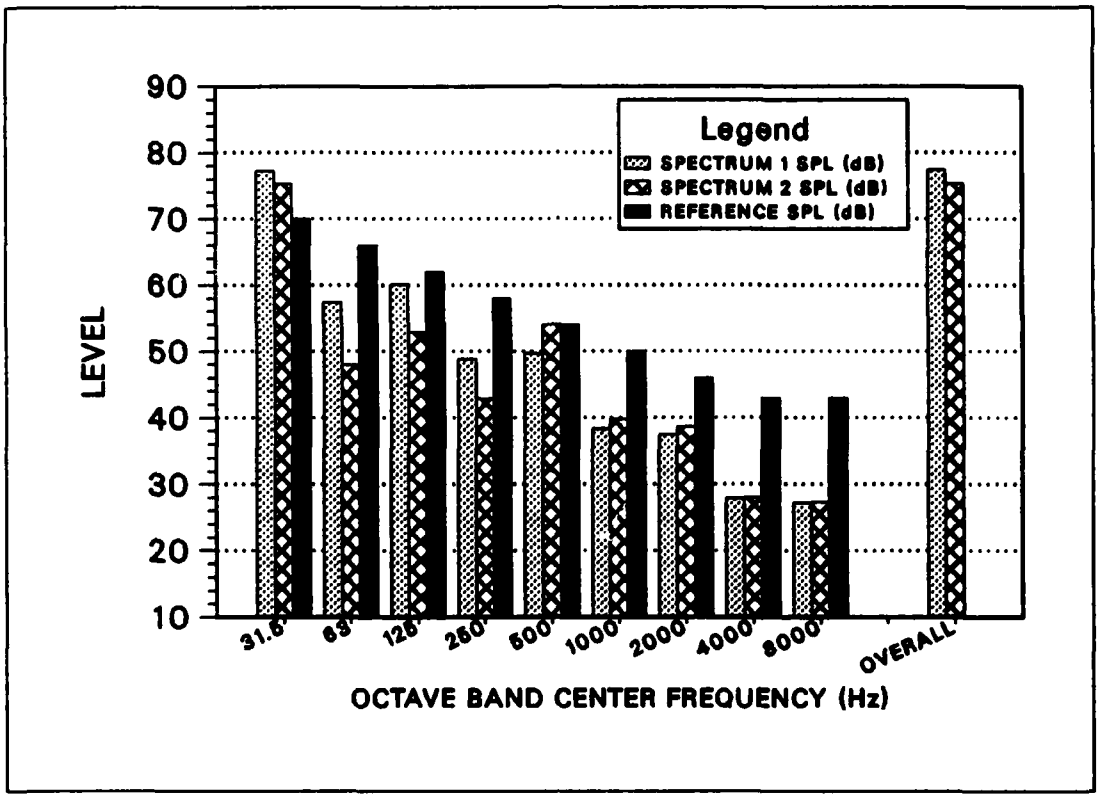
Performance Comparison Measurements

Sierra 00 Serviced vs Unserviced MGS



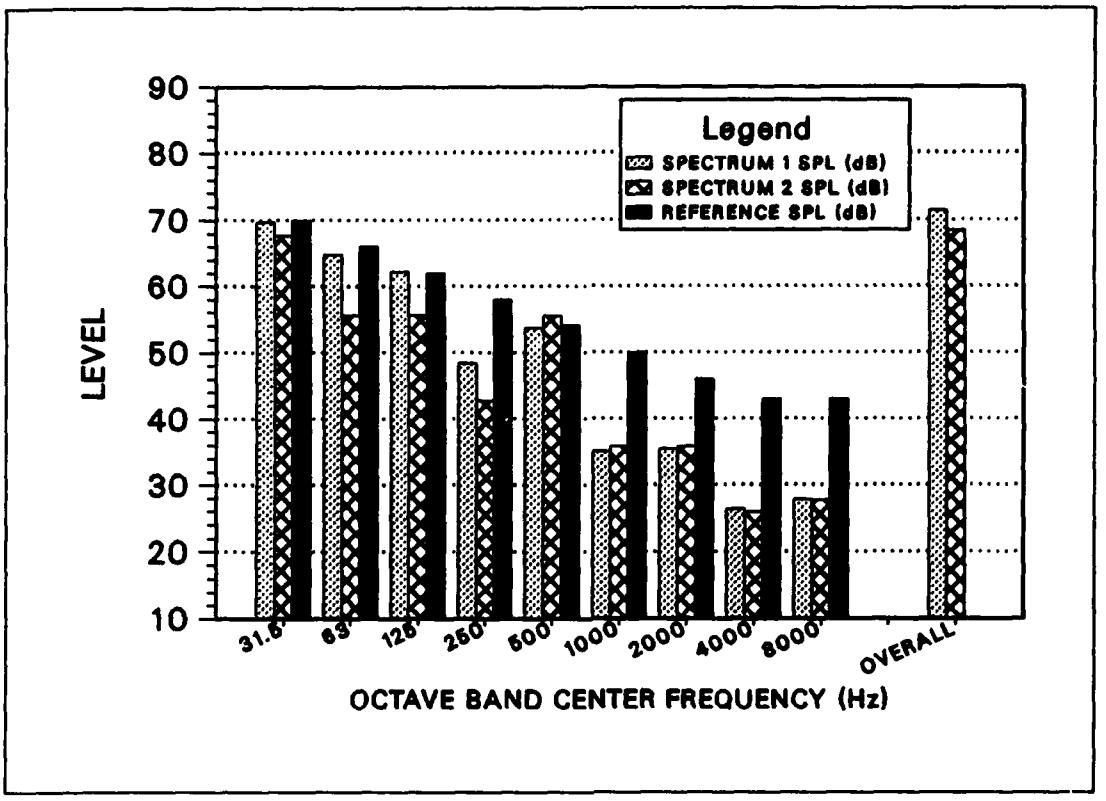
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	76.3	71.6	70
63	66.2	59.4	66
125	58.4	56.3	62
250	50.1	42	58
500	53.3	54.4	54
1,000	39.1	37.5	50
2,000	36.6	37	46
4,000	26.6	27.3	43
8,000	27.4	27.4	43
OVERALL	76.7	72.1	

Sierra 00 acoustic tests at the commander's chair in AC power operation with no load with carpet.
Spectrum 1: Measured SPL before servicing of motor generator.
Spectrum 2: Measured SPL after servicing of motor generator.
Reference: PNC-50 Criteria.



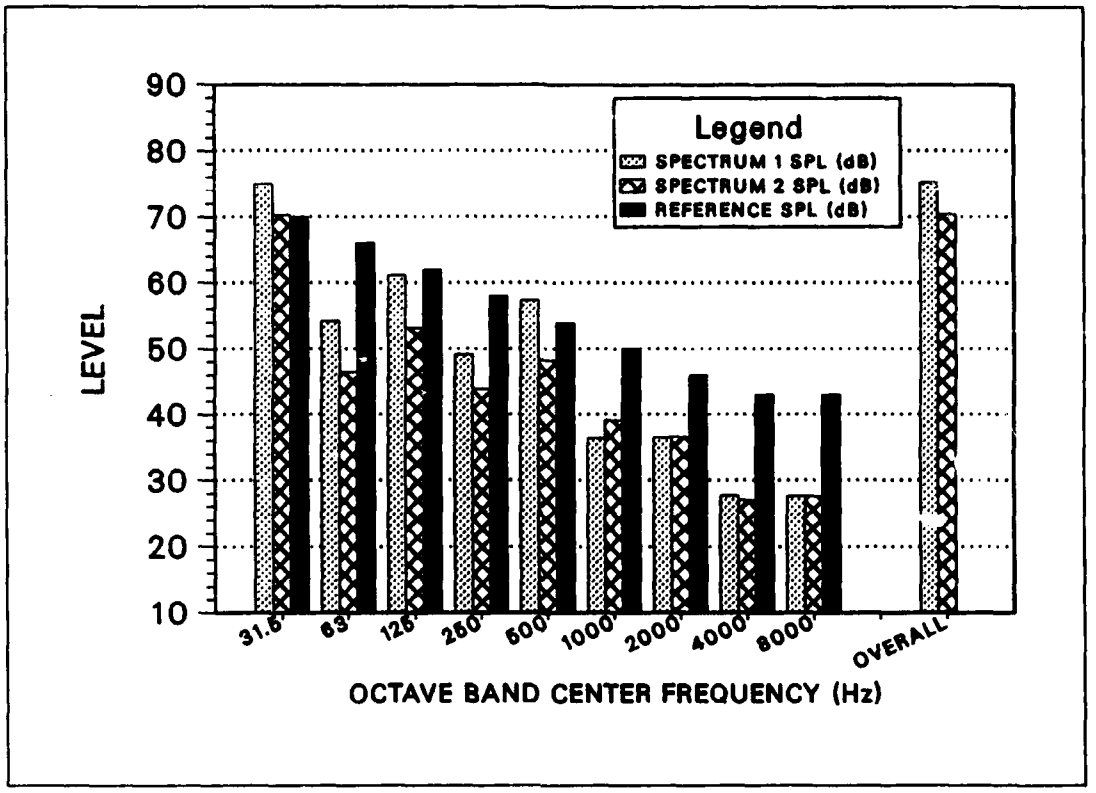
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	77.3	75.3	70
63	57.4	47.9	66
125	60.1	52.9	62
250	48.8	42.9	58
500	49.6	54	54
1,000	38.3	39.8	50
2,000	37.5	38.6	46
4,000	27.9	28	43
8,000	27.2	27.3	43
OVERALL	77.4	75.3	

Sierra 00 acoustic tests at the deputy commander's chair in AC power operation with no load with carpet.
Spectrum 1: Measured SPL before servicing of motor generator.
Spectrum 2: Measured SPL after servicing of motor generator.
Reference: PNC-50 Criteria.



FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	69.7	67.6	70
63	64.8	55.6	66
125	62.1	55.6	62
250	48.4	42.8	58
500	53.6	55.4	54
1,000	35	35.8	50
2,000	35.5	35.8	46
4,000	26.3	25.8	43
8,000	27.8	27.7	43
OVERALL	71.5	68.4	

Sierra 00 acoustic tests at the commander's chair in DC power operation with no load with carpet.
Spectrum 1: Measured SPL before servicing of motor generator.
Spectrum 2: Measured SPL after servicing of motor generator.
Reference: PNC-50 Criteria.



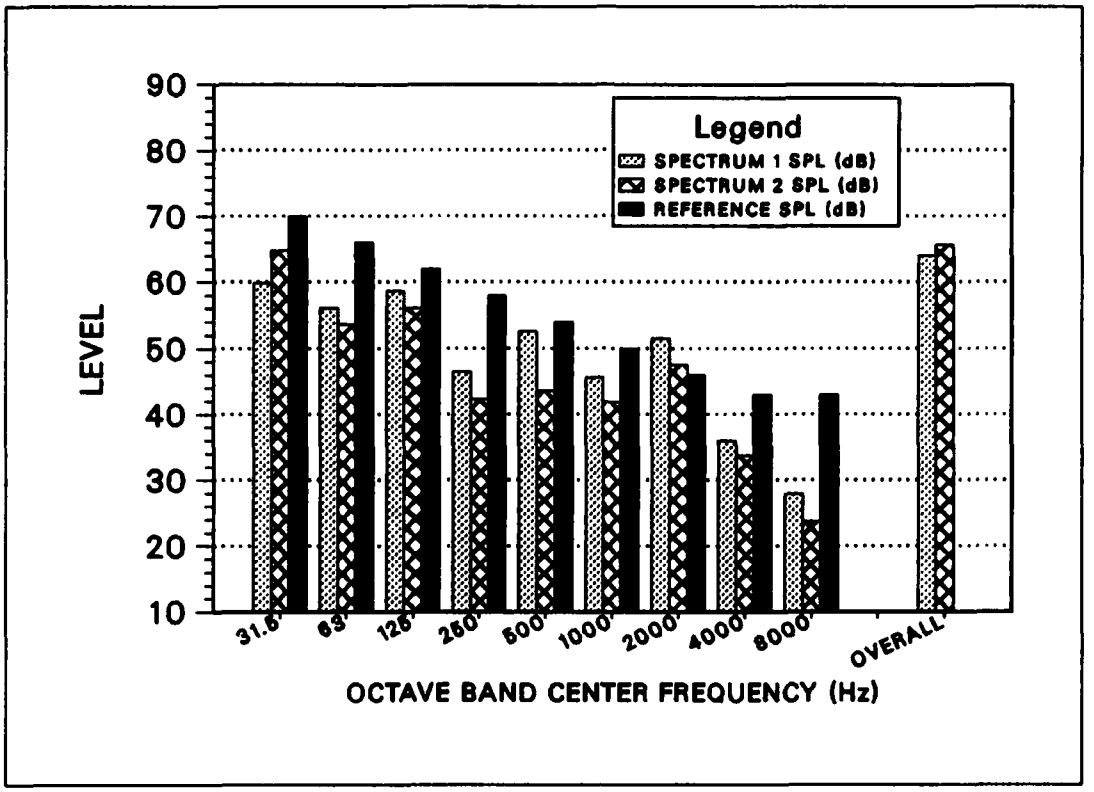
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	74.9	70.3	70
63	54.2	46.5	66
125	61.1	53.2	62
250	49.1	43.9	58
500	57.3	48.2	54
1,000	36.4	39.1	50
2,000	36.5	36.6	46
4,000	27.7	27	43
8,000	27.6	27.6	43
OVERALL	75.2	70.4	

Sierra 00 acoustic tests at the deputy commander's chair in DC power operation with no load with carpet.
Spectrum 1: Measured SPL before servicing of motor generator.
Spectrum 2: Measured SPL after servicing of motor generator.
Reference: PNC-50 Criteria.

APPENDIX G

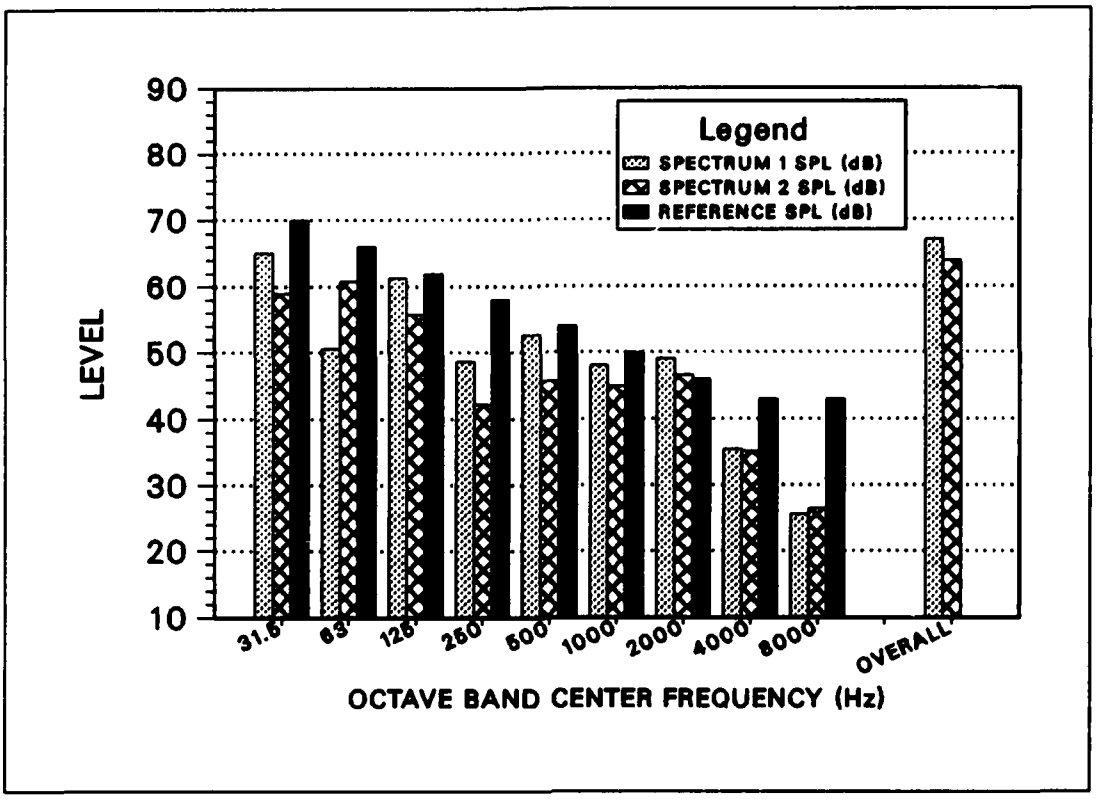
Performance Comparison Measurements

Alpha 01 vs HETF I



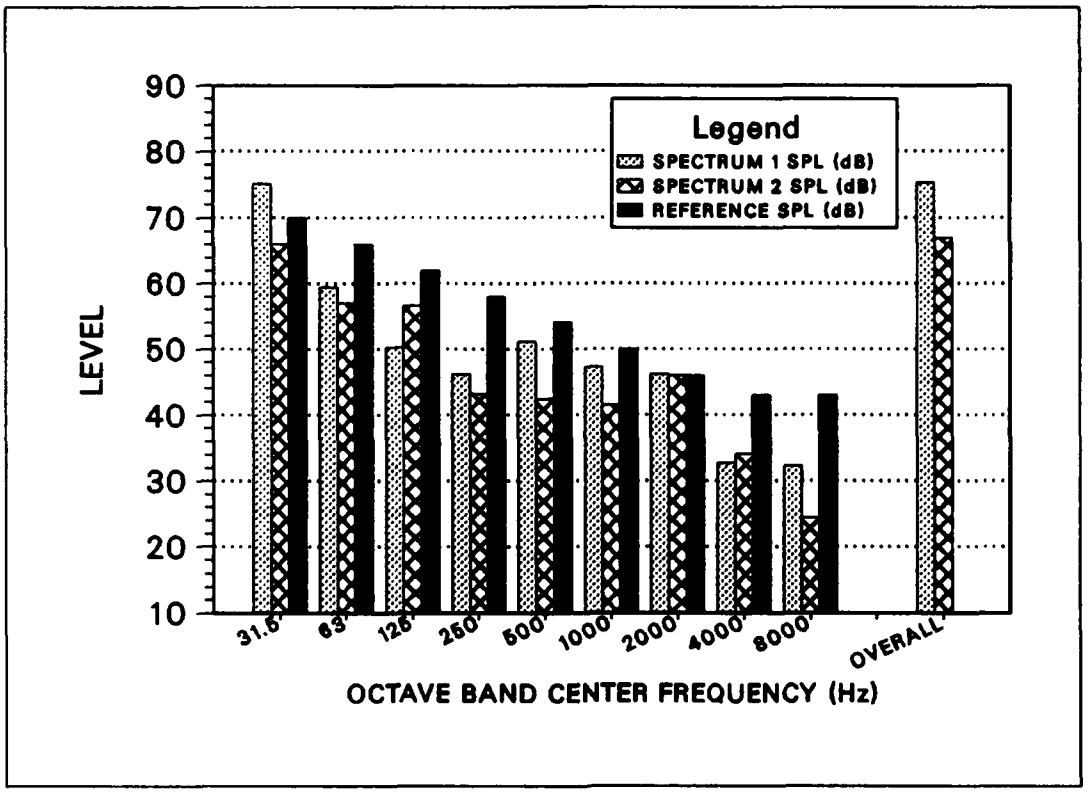
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	59.8	64.7	70
63	56	53.6	66
125	58.7	56	62
250	46.5	42.3	58
500	52.5	43.5	54
1,000	45.6	41.8	50
2,000	51.5	47.5	46
4,000	35.9	33.7	43
8,000	27.9	23.7	43
OVERALL	64	65.7	

Acoustic tests at the commander's chair with the new motor generator in AC power operation with no load.
Spectrum 1: Measured SPL at Alpha 01.
Spectrum 2: Measured SPL at HETF I.
Reference: PNC-50 Criteria.



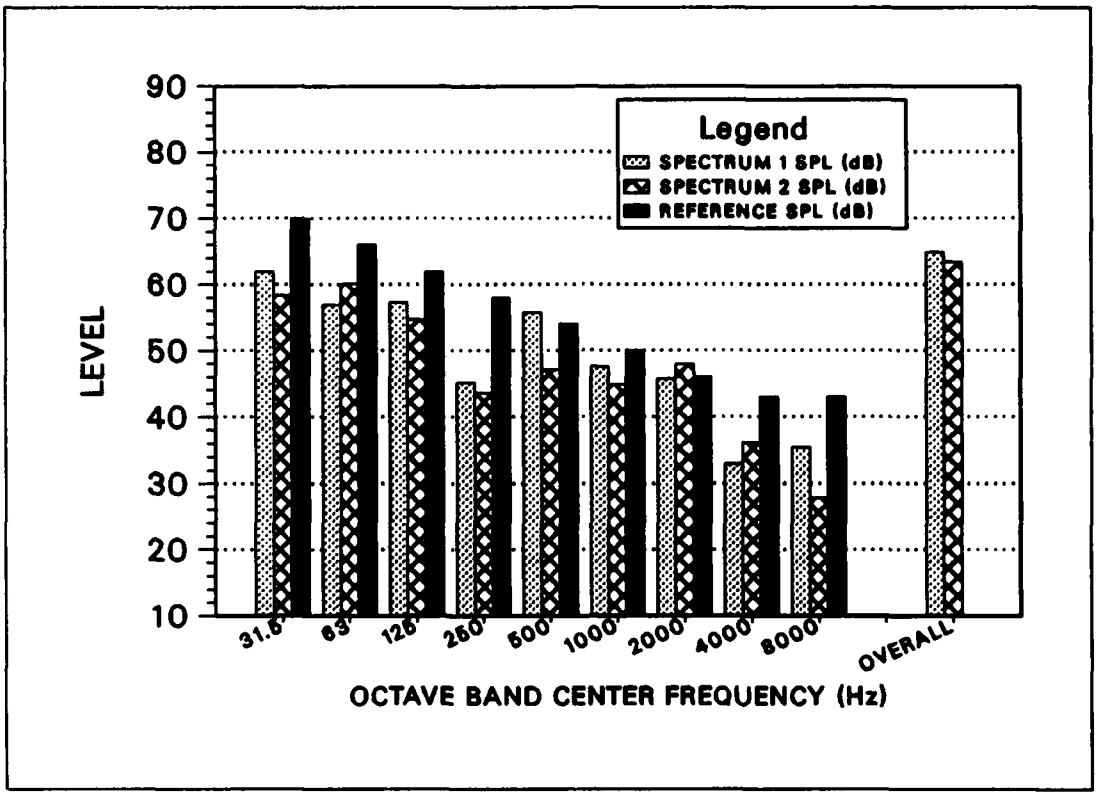
FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	65.1	59	70
63	50.5	60.8	66
125	61.3	55.7	62
250	48.6	42.2	58
500	52.6	45.7	54
1,000	48	44.9	50
2,000	49	46.6	46
4,000	35.4	35.2	43
8,000	25.6	26.5	43
OVERALL	67.1	63.9	

Acoustic tests at the deputy commander's chair with the new motor generator in AC power operation with no load.
Spectrum 1: Measured SPL at Alpha 01.
Spectrum 2: Measured SPL at HETF I.
Reference: PNC-50 Criteria.



FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	75.1	66	70
63	59.4	57	66
125	50.2	56.6	62
250	46.2	43.2	58
500	51.1	42.4	54
1,000	47.2	41.6	50
2,000	46.2	46	46
4,000	32.7	34.1	43
8,000	32.3	24.4	43
OVERALL	75.3	67	

Acoustic tests at the commander's chair with the new motor generator in DC power operation with no load.
Spectrum 1: Measured SPL at Alpha 01.
Spectrum 2: Measured SPL at HETF I.
Reference: PNC-50 Criteria.



FREQ (Hz)	SPECTRUM 1 SOUND PRESSURE LEVEL (dB)	SPECTRUM 2 SOUND PRESSURE LEVEL (dB)	REFERENCE SOUND PRESSURE LEVEL (dB)
31.5	62	58.4	70
63	56.9	60.1	66
125	57.3	54.7	62
250	45.1	43.5	58
500	55.7	47	54
1,000	47.5	44.8	50
2,000	45.7	47.9	46
4,000	32.9	36.1	43
8,000	35.4	27.8	43
OVERALL	64.9	63.4	

Acoustic tests at the deputy commander's chair with the new motor generator in DC power operation with no load.
Spectrum 1: Measured SPL at Alpha 01.
Spectrum 2: Measured SPL at HETF I.
Reference: PNC-50 Criteria.

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